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EDINBURGH, *July* 1901.

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*On the Solution of Some Problems which frequently arise out of the Rules of Pension Funds and Friendly Societies, H. W. MANLY.
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A Present-day Problem

BEING

THE INAUGURAL ADDRESS FOR THE SESSION 1896-97

BY

DAVID PAULIN, F.F.A., F.R.S.E., F.S.S.

MANAGER OF THE SCOTTISH LIFE ASSURANCE COMPANY

HONORARY PRESIDENT OF THE SOCIETY

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VOL. IV.

Old Age Pensions and Pauperism

A PRESENT-DAY PROBLEM

GENTLEMEN,—I have to thank you sincerely for the honour you have conferred upon me in calling me to fill the office of Honorary President this Session. I accepted the honour with hesitation, recollecting the long list of distinguished men who have occupied and adorned the high office since the year 1859, and whose Inaugural Addresses we cherish as a valuable heritage. I felt, however, under such great obligations to the Society for having opened up to me in the past so many new fields of study that I could not refuse to undertake any service to which by your goodwill I might be called.

The subject of State Pensions for the Aged Poor, which I propose to bring under your notice to-night, is one which has occupied public interest and attention to a large extent during recent years. Suggestions numerous and varied have been made for the solution of the difficulties which surround the question, but the problem unsolved still holds the field. This winter it will be again much in evidence, as a Committee on Old Age Pensions, appointed by Government, will meet at the Treasury from time to time under the presidency of Lord Rothschild. It has been remitted to this Committee

"to consider any schemes that may be submitted to them for encouraging the industrial population, by State aid or otherwise, to make provision for old age, and to report whether they can recommend the adoption of any proposals of the kind, either based upon or independent of such schemes, with special regard, in the case of any proposals of which they may approve, to ascertain their cost and probable financial results to the Exchequer and to local rates; their effect in promoting habits of thrift and self-reliance; their influence on the prosperity of the friendly societies; and the possibility of securing the co-operation of these institutions in their practical working."

The recognition by Government of the Actuarial profession in important financial questions of this kind is gratifying. In the small Committee of Experts, who are to sit as judges upon the schemes that may be proposed, are the President and one of the Vice-Presidents of the Institute of Actuaries, and the Actuary of one of the largest of the Friendly Societies. Other members of the Committee are specially fitted to consider the subject from the sociological, political, and *economical* standpoints, but seeing

that the subject involves calculation of the cost to the ratepayers and individual beneficiaries of benefits largely dependent on interest, mortality, and cost of working, the Actuarial opinion and advice will be specially valuable.

I shall endeavour to bring under your notice some considerations which appear to me to be sufficient to cast a doubt on the advisability of the adoption of any of the schemes for State Pensioning or Partial Pensioning which have been proposed; and I would at the outset state it as my opinion that we are as a nation, by the best of all methods, self-help, and self-controlled association springing from the people themselves, tending surely towards the desired goal; and that the short-cuts of State Pensioning which have been proposed would do infinitely more harm to the national life and wellbeing than the good they would accomplish in isolated cases, and might land the country in an irreparable and mischievous position, in waste of means and in the weakening of the moral fibre of the people. These are the conclusions to which I have come after carefully reading and considering all the schemes that have been proposed. While it is customary to defer stating conclusions till towards the end of the paper, yet as the subject is still in the argumentative stage, and involves the use of statistics to a fatiguing extent, I have thought it better to state broadly my opinion, and then to proceed to give the reasons that have led me to form it.

The long reign of our gracious Queen has been signalised in many ways, but in none more than by the great change for the better that has taken place in the comfort and wellbeing of the working classes, and in the means and methods of relieving the suffering poor, whether afflicted in body or in mind. These improvements have taken place in much greater degree during the last three decades than in the first three, and are becoming increasingly apparent and fruitful.

In support of the conclusions I have come to I submit evidence relating to the following three points:—

First.—The number of paupers relative to the population has greatly decreased.

Second.—The condition of the working classes has improved in many ways, but especially as regards wages.

Third.—The means of thrift and provision for old age within reach of the working classes have been multiplied and improved, and are being taken advantage of to an extent that must largely diminish pauperism in the future.

If these three points can be established, it will, I think, be admitted that the deplorable amount of old-age pauperism now existing has sprung from, or been bred by, a condition of things which does not now exist, and that there is reason to hope that

the present generation of working men, if not interfered with, is able to grapple with the problem of how to provide for themselves when old age brings debility or a desire for rest.

I. Decrease of Pauperism.—A Royal Commission on the Aged Poor was appointed in 1893 to consider whether any alterations in the system of Poor Law Relief are desirable in the case of persons whose destitution is occasioned by incapacity for work resulting from old age, or whether assistance could otherwise be afforded in those cases.

The Report of the Committee was issued last year, and is a perfect cyclopædia of useful information on every subject relating to better provision for the Aged Poor. The Report and relative evidence afford glimpses of the evils which attended the indiscriminate outdoor relief, which was given before the Act of 1834 came into force. It also shows that if every person in the Kingdom 65 years of age and upwards were immediately to be endowed with a pension of 5s. per week, there would still be a large mass of pauperism left which would require the upkeep of almost the whole present equipment for relief of the poor; and further consideration of the evidence leads one to question whether a large proportion of the Aged Poor would be as well off with a pension of 5s. per week, as they are at present under the greatly ameliorated provision now made for indoor relief. From this interesting Report I extract the following Table giving the numbers of Indoor and Outdoor Poor in England and Wales, and their ratio to the population for a number of years from 1849-1892.

Year.	No. of Indoor Poor.	No. per 1000 of Population.	No. of Outdoor Poor.	No. per 1000 of Population.	Total.	No. per 1000 of Population.
1849	133,513	7·7	955,146	55·	1,088,659	62·7
1852	111,323	6·2	804,352	44·7	915,675	50·9
1862	132,236	6·6	784,906	39·	917,142	45·6
1872	149,200	6·6	828,000	36·3	977,200	42·9
1882	183,374	7·1	604,915	23·2	788,289	30·3
1892	186,607	6·4	558,150	19·2	744,757	25·6

You will notice that though the numbers of those receiving indoor relief had increased by 53,094 the ratio to population had slightly decreased. There is, however, a very marked decrease in the numbers receiving outdoor relief, the ratio declining from 55 per thousand in 1849 to 19·2 per thousand in 1892. The decrease in the total number of paupers during these forty-three years, was no less than 343,902, the ratio per thousand of population falling from 62·7 to 25·6.

Mr. C. S. Loch, Secretary to the London Charity Organisation Society, in his admirable treatise on "Old Age Pensions and Pauperism," sums up his remarks on this subject as follows:—"Pauperism in England and Wales has largely decreased since "1870. On the 1st January in that year the able-bodied and not "able-bodied paupers, exclusively of lunatics, etc., vagrants and "children were 641,785. On the 1st January 1890 they numbered "471,817. So far, good. The great decrease in the figures "represents a corresponding decrease in the alleged need of some "national pension scheme."

Sir Hugh Owen, Permanent Secretary to the Local Government Board, states that the decrease in the number of paupers has been very steady, and has been shown in most years; and that during the whole period under review "there has been no alteration of "the law, and the law has been administered by the same bodies." As to the cause, he states, "no doubt the general improvement of "the condition of the working classes has had much to do with the "decrease. It is, however, impossible to say to what extent the "decrease is to be attributed to this cause or that, but the stricter "administration, I think it is quite certain, has had its share and a "considerable share, in securing this result."

He gives the figures for four Unions which he says have adopted the principles of the Poor Law Commission in their entirety, viz.—Brixworth, Bradfield, St. George-in-the-East, and Stepney, which show a very remarkable decrease of Pauperism since 1870, and he adds, "If these principles were generally adopted, it is not too "much to say that in a comparatively short time, instead of one "in seven, or 14 per cent., of the population over sixty being "paupers, old-age pauperism might be reduced in the country to "a minimum, and in the metropolis and other towns by more than "half."

The following table, extracted from the Report of this Commission, gives the number of the poor in England and Wales in 1891, arranged according to age and relatively to the population at the same ages:—

Age Period.	Population 1891.	No. of Paupers (on day of count).	No. of Paupers per 1000 of Population at the Age Period.
Under 16, . . .	10,762,808	229,178	21
Between 16 and 65, . .	16,867,116	203,171	12
,, 60 and 65, . .	772,879	41,180	53
,, 65 and 70, . .	571,947	62,240	109
,, 70 and 75, . .	417,914	77,708	185
,, 75 and 80, . .	233,333	60,879	261
Upwards of 80, . .	149,407	44,860	300

This table shows that out of a population of 1,372,601 above 65, 245,687 persons were in receipt of relief on the day of count, while 432,349 persons under the age of 65 were in receipt of relief on the same day.

While the number of indoor poor, aged 60 or over, had increased between 1st January 1872 and 1st January 1892, the number of outdoor poor had in the same period decreased from 16·2 per thousand to 8·8 per thousand. The total number of non-able-bodied poor which, on 1st January 1872, was 434,400, had decreased on 1st January 1892 to 350,838.

As regards Scotland, Mr. Malcolm M'Neill, Secretary to the Board of Supervision, Edinburgh, in his evidence before the Commission, stated that "both the outdoor and the indoor pauperism is falling." In 1873 the total pauperism of Scotland was 116,107, and in 1892 it had fallen to 90,792. The total number 60 years of age and upwards in 1892 was 24,767 paupers and 1510 dependants. The rate of pauperism of the estimated population in 1893 was 22·8 per 1000.

You will notice that the ratio of pauperism to population in Scotland is considerably beneath the ratio in England.

The following table exhibits the number of paupers of all classes in receipt of relief for each of the twenty years from 1876-1895, with the ratio per thousand persons in receipt of parochial relief:—

Year.	No. of Paupers of all classes, including Dependants in receipt of Relief on the same day, 14th May.	Estimated Population (Scotland).	Ratio per 1000 of Persons in receipt of Parochial Relief to Population.
1876	102,658	3,547,228	28
1877	100,640	3,584,670	28
1878	99,398	3,622,112	27
1879	102,899	3,659,554	28
1880	103,186	3,696,996	27
1881	102,306	3,735,573	27
1882	99,341	3,764,580	26
1883	97,097	3,793,587	26
1884	94,642	3,822,594	25
1885	95,516	3,851,601	25
1886	97,504	3,880,608	25
1887	96,536	3,909,615	25
1888	96,226	3,938,622	24
1889	94,836	3,967,629	24
1890	92,824	3,996,636	23
1891	91,063	4,025,647	23
1892	90,792	4,054,654	22
1893	92,004	4,083,661	23
1894	93,682	4,112,668	23
1895	95,868	4,141,675	23

The above figures include the lunatic poor, who have increased from 6976 in 1876 to 11,551 in 1895. The ordinary poor in Scotland have decreased from 130,441 in 1868 to 84,317 in 1895, that is, from 40 per thousand of the estimated population in 1868 to 20 per thousand in 1895.

The foregoing figures are sufficient, I hope, to prove the truth of my first contention, viz.:—that the number of paupers relative to the population has greatly decreased.

II. Increased Earnings of the Working Classes.—In regard to the increase of the earnings of working men during the last fifty years, I would call in evidence Sir Robert Giffen, Statistician to the Board of Trade, and the figures which he submitted in two papers read before the Statistical Society of London, in which he showed that the working classes are on an average nearly twice as well off to-day as they were fifty years ago. "The improvement "may be stated as at least between 50 and 100 per cent., and "with an allowance for the shortening of the hours of labour, may "be placed nearer the 100 than the 50, if not over the 100."

One of the tables he submitted in his first paper, read in 1883, showed a comparison of the weekly wages at the two periods and the percentage of increase which had taken place.

Comparison of Wages in 1833 and 1883.[1]

Occupation.	Place.	Wages per Week. 1833.			Wages per Week. 1883.			Increase per Cent.
		£	s.	d.	£	s.	d.	
Carpenters,	Manchester,	1	4	0	1	14	0	42
,,	Glasgow,	0	14	0	1	6	0	85
Bricklayers,	Manchester,*	1	4	0	1	16	0	50
,,	Glasgow,	0	15	0	1	7	0	80
Masons,	Manchester,*	1	4	0	1	9	10	24
,,	Glasgow,	0	14	0	1	3	8	69
Miners,	Staffordshire,	0	2	8†	0	4	0†	50
Pattern-weavers,	Huddersfield,	0	16	0	1	5	0	55
Wool-scourers,	,,	0	17	0	1	2	0	30
Mule-spinners,	,,	1	5	6	1	10	0	20
Weavers,	,,	0	12	0	1	6	0	115
Warpers and beamers,	,,	0	17	0	1	7	0	58
Winders and reelers,	,,	0	6	0	0	11	0	83
Weavers (men),	Bradford,	0	8	3	1	0	6	150
Reeling and warping,	,,	0	7	9	0	15	6	100
Spinning (children),	,,	0	4	5	0	11	6	100

* 1825. † Wages per day.

In a more recent paper he shows that a similar rise has taken

[1] There has been no decrease in the average wage since 1883. The tendency has been still upward.

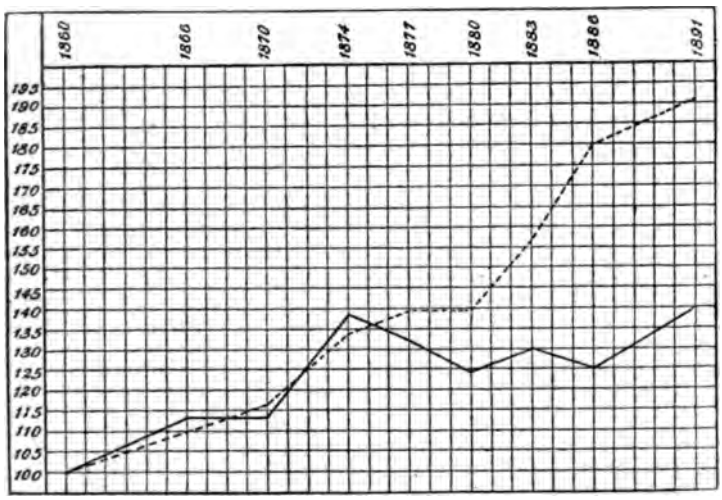
place in the wages of unskilled labour (non-agricultural). The following are some of the particulars :—

WAGES OF UNSKILLED LABOUR (NON-AGRICULTURAL) FIFTY YEARS AGO AND AT THE PRESENT TIME.

	Fifty Years Ago.			Present Time.			Increase per Cent.
	£	s.	d.	£	s.	d.	
Labourers, London,	0	15	0	1	5	0	67
,, Bradford,	0	15	0	1	1	9	50
Bricklayers' labourers, Manchester,	0	12	0	1	2	0	83
Spademen, Manchester (maximum),	0	15	0	1	2	0	50
Bricklayers' labourers, Glasgow,	0	9	0	0	18	0*	100
Stocking-makers, Leicester,	0	8	3	0	14	0†	70
Labourers, Londonderry,	0	8	0	0	16	0‡	100

* 48 hours weekly, at 4½d. per hour.
† Lowest wage quoted for Leicester. ‡ Dublin.

In a paper read by Mr. A. L. Bowley before the Statistical Society last year on "Changes in Average Wages (Nominal and Real) in the United Kingdom between 1860 and 1891," very interesting tables are given which confirm the figures given above by the Government Statistician, and bring them up to a more recent date. The following diagram illustrates the figures given by him :—



——— Increase of average *nominal* weekly wages.
..... Increase of average *real* weekly wages.

You will notice that the nominal wages have in these thirty-one years risen 40 per cent. Owing, however, to the price of commodities having fallen largely, the purchasing power of the increased wages makes the rise equivalent to 90 per cent.

According to the late Sir James Caird, the average rise in the wages of agricultural labourers has been about 60 per cent. during the last forty years. The evidence given by expert witnesses before the Royal Commission on the Aged Poor is to the same effect. Mr. Geoffrey Drage, in his recent book on *The Labour Problem*, makes the following statement:—

"In addition to the rise in wages in certain specific trades, there has been a gradual substitution of the better-paid for the less-paid industries, so that the proportion which persons receiving very low wages bears to the total population is much smaller now than it was formerly. For instance, at the present time, less than one-fifth of the working population of the United Kingdom, and about one-eighth of that of Great Britain alone, are peasant farmers or agricultural labourers; whilst fifty years ago agricultural labour engaged about half the working population of the United Kingdom at even lower wages than they now receive."

In many other respects besides money wages the condition of the working man has been ameliorated; chief among these are the shorter hours of labour and the greater security and independence which he now enjoys.

The working classes are better housed and fed, and they enjoy better health and longer life than the former generation, especially in the large towns. Take as illustration of this the statistics submitted to the Edinburgh Town Council last month by the Convener of the Health Committee. He submitted a table giving the ratio of mortality to the population from 1864 to 1896, showing a remarkable decrease all along the line. In the first five years of the period the average mortality was 27·40 per 1000, while in the last year ending 15th May 1896 it had fallen to 15·51. He remarks:—

"Thirty years ago, in a population of 175,015, there died annually 4805 persons; last year, in a population of 276,514, an increase of 101,499, there died only 4271 persons. That is to say, 534 fewer deaths occurred last year, though the population has increased by more than half, than took place thirty years ago. It is a striking and most noteworthy fact that within a moderate-sized city like Edinburgh we may now reckon that every year there are actually saved 3344 lives, which must certainly have been lost if the health conditions of the people were now no better than they were only a generation ago."

A legitimate inference from this is, that working men have less sickness now than the former generation had, and consequently lose fewer days' wages. The cost of food and clothes, and of most other commodities which are in daily use in a workman's house, is *much* less than it was fifty years ago. The two items of expense

which have risen in cost are house-rent and butcher-meat. Against this, however, may be placed the very considerable saving in the fact that there are now no fees to pay for the education of their children.

The consensus of opinion in the evidence given before the Commission on the Aged Poor was to the effect that from these improved conditions, the working classes, if they did not spend too much on drink and tobacco, were able to make provision for themselves for sickness and old age; the only discordant note being in reference to the ability of the agricultural labourers, out of their increased but still comparatively small wages, to do it. There were, however, a considerable number of reliable witnesses who gave evidence of the fact that in many parts of the country, where only the average wage was paid, the labourers were actually making both these provisions for themselves.

I hope the foregoing figures and facts have satisfactorily proved my second contention, viz.:—That the condition of the working classes has improved in many ways, but especially as regards wages.

III. Means of Thrift and Provision for Old Age are Improving and Increasing.

1. *Savings Banks.*

One of the agencies of thrift most readily accessible to the working classes is the Savings Bank. During 1895 the total number of depositors increased from seven and a half to nearly eight millions, and the fact that the average sum paid in amounts to £3 indicates clearly that most of the depositors belong to the wage-earning classes, and that the sums saved are the result of self-denying thrift.

The deposits in the Post Office Savings Banks may be roundly stated at £100,000,000. Since 1861, when these banks were first established, they have received on deposit the large sum of £414,426,190, and in the same period there has been drawn out £337,520,419.

The deposits in the Trustees' Savings Banks amounted last November to £46,307,858; the total sum received since 1817 has been £315,978,718, while the total payments made have amounted to £349,971,976. The sum paid in excess of the sum received, and the sum now at the credit of depositors, amounting together to £80,301,116, is the result of interest being added to the deposits.

There is thus lying in the Savings Banks of the country alone the sum of £146,000,000.

The amount of money saved in this way by the industrial classes has increased during the reign of her present Majesty

sevenfold; the greater portion of which would have been lost to the thrifty classes and to the country if it had not been for the facilities which these admirable institutions brought to the very doors of the wage-earning classes.

The capital deposited in the Post Office Savings Banks has increased by considerably more than fifty millions during the last ten years, and it is reasonable to suppose that the provision made by the wage-earning classes, through this medium, will continue to grow at an even greater ratio in the future.

In England and Ireland the deposits in the Post Office Banks largely exceed those in the Trustee Savings Banks. In Scotland it is exactly the opposite. The figures there are, Trustee Banks £11,390,491, and Post Office Banks £2,329,430.

The following statement of the business of the Trustees' Savings Banks in Glasgow and in Edinburgh is in this connection both interesting and instructive: the Trustee Savings Bank in Glasgow has 188,942 open accounts, with deposits amounting to £7,415,000, while that in Edinburgh has 72,000 depositors with deposits amounting to £2,703,502.

2. *Endowment Assurances.*

The next point I make proving that the working classes are largely making provision for their old age, is one that will be familiar to each member of this Society. I refer to the enormous increase which has taken place in the development of Endowment Assurances within the last ten years, and especially in the granting of such policies for small sums which are undoubtedly passing into the hands of the wage-earning classes, not only for provision for their families in the event of death, but also for themselves when age deprives them of the ability to work.

It is not possible to determine exactly the number and the amount of the Endowment Assurances now being issued, as the required information is not generally afforded in the returns of the Assurance Companies; but we may obtain indirectly a very fair idea of the rate of progress.

In 1887 the Board of Trade added to the returns presented to Parliament a summary of the assurances in force as shown by the last valuation returns of the Companies, and they have continued it down to the present time.

In the return relating to the year 1887, the total net amount of business in force is stated to be £421,061,768. Of these, £380,752,944 were Whole-Life Assurances, and £25,980,743 Endowment Assurances. In the last return, which relates to the year 1895, the total net amount of business in force is stated to be £529,184,344, of which £423,344,139 were Whole-Life Assurances and £85,144,665 Endowment Assurances.

The total net business, therefore, increased by 25·7 per cent., the Whole-Life Assurances by 11·2 per cent., and the Endowment Assurances by 227·7 per cent.

If we take the number of policies instead of the amount, the increase is still more remarkable. The gross number of Whole-Life Assurances, with profits, in force in the return for 1887 is stated to be 675,368, and the Endowment Assurances 98,176, while in the 1895 return the numbers are 772,531 and 449,337 respectively.

The increase in the number of Whole-Life Assurances, therefore, is 14·4 per cent., and in the Endowment Assurances, 357·7 per cent.

In a footnote to the summary it is explained that the figures are based on returns deposited for the most part during the past five years, and are therefore merely an approximation of the amount of contracts in force at the present time, and there is no doubt that the increase in the Endowment Assurances would have been even more startling had the figures applicable to the years we have been dealing with been available for each office.

While Endowment Assurances now form an important branch of the business of ordinary Life Offices, it is in the industrial offices that the development has been greatest. The figures of the ordinary branch of the largest of these offices are so interesting that I give them for with-profit policies at the three last valuations in the two classes of Whole-Life and Endowment Assurances.

	Whole-Life Assurances by Uniform Annual Premiums.		Endowment Assurances.	
	Number.	Amount.	Number.	Amount.
In force 31st Dec. 1886,	67,696	£6,398,160	28,600	£2,840,291
,, ,, 1891,	87,581	11,713,566	161,416	15,387,999
,, ,, 1894,	107,074	15,296,655	252,756	25,023,609

It will be seen that while the Whole-Life Assurances in force have been more than doubled, the Endowment Assurances have increased nearly ninefold, and that during the short space of eight years the relative positions of the Whole-Life and Endowment Assurances have been reversed. In 1886 the amount of Endowment Assurances was less than one half of the amount of the Whole-Life Assurances, whereas in 1894 the amount of the former was more than 1½ times the latter.

The Actuary of that Office has kindly supplied me with the following somewhat more recent figures:—In the ordinary Branch

they have 314,000 Endowment Assurance Policies in force, while they have only granted 72 Deferred Annuities. Their experience is that the public will not purchase deferred Annuities because they may not live to reap the benefit. Last year the Company issued about 50,000 Endowment Assurance Policies for nearly £5,000,000.

Reverting to the general subject of Endowment Assurances, these figures prove conclusively that the working classes are in large numbers, and in larger numbers every year, availing themselves of this form of thrift, the benefits of which they consider superior to deferred annuities or old-age pensions, which are so much lauded and advocated in all the recent schemes for the relief of pauperism.

I do not think Government should compel, or subsidise the adoption of any form of thrift, though it should do everything in its power to encourage and facilitate wise methods. Those persons who so warmly advocate State Pensions for the aged might consider whether there are no better methods of provision, by which pauperism might in most cases be prevented instead of being merely relieved. To a large extent the pauperism of the country is composed of women and children who have been left widows and orphans by the death of the breadwinners. The statistics for the last year show that the adult females relieved were nearly double the number of the adult males, and the children under 16 also numbered more than the adult males. If this beneficent system of Endowment Assurance had been earlier developed a large proportion of these destitute women and children would have been provided for outside the Poor Law.

Old-Age Pensions are a somewhat selfish form of saving, and are unpopular among the working classes, unless linked on with other benefits more immediately available. Endowment Assurances, costing little more than the single benefit which Old-Age Pensions afford, give the double benefit of provision in old age to the assurer himself, and protection to his wife and children from the evils of penury and pauperism in the event of his death. Even to the extent that these Endowment Assurances have been already adopted, they must prove later on an important factor in reducing pauperism. We may well express the hope that this form of thrift will become more widely known, and will be taken advantage of in the future by increasing numbers of working men.

3. *Building Societies.*

Building Societies are another agency of thrift that has contributed largely to the wellbeing of the working classes. In Lancashire and Yorkshire they seem to have taken a greater hold than in other parts of the country, and they have been managed with

greater success and integrity there than those in the southern districts of England. The failures of the "Liberator" and "Portsea Island" Building Societies gave a great shock to public confidence in this form of thrift; but these terrible calamities to many individuals, Mr. Brabrook remarks, "have proved by no means an unmixed evil to the community at large." They led to the passing of the Building Societies Act of 1894, by means of which similar frauds will be rendered wellnigh impossible in future. The terrible revelations in connection with these frauds have done for Building Societies what the failures of the "Albert" and "European" Assurance Companies did for the Life Assurance Companies in this country. It is to the revelations in connection with the failures of these two Companies that we are indebted for the passing of the Life Assurance Companies Act of 1870; and it would be as unjust to condemn and discredit Building Societies for their failures before the passing of the new Act, as it would be to condemn and discredit the system of Life Assurance for the failures that took place before the passing of the Act of 1870.

The effect of these failures has been to decrease the assets of the building societies to a considerable extent since 1892, and it is probable that while the medicine which the 1894 Act supplies is working out the cure there may be a further decrease; but the ultimate effect, there is little doubt, will be to put building societies on a firmer footing than ever. The progress of these societies has been such that the assets, which in 1872 were only seventeen millions, had increased to over forty-two millions in 1893. Before the "Liberator" crash took place the funds of these societies rose to over £50,000,000.

Mr. Fatkin, Manager and Actuary of the Leeds Permanent Benefit Building Society, recently told me that he believed the working classes of Leeds and neighbourhood had accumulated, through his Society alone, property to the extent of five millions sterling; while the sum at the credit of the members and depositors was now £1,500,000, having increased during the last twenty-five years by over £1,000,000.

There are many other very successful building societies in Yorkshire and Lancashire, by which the working classes have been enabled to become their own landlords to a large extent, and which have done a great deal to improve the homes of the wage-earning classes in that part of England.

As the proportion of income which is paid for house-rent by the working classes is from 10 per cent. in the country to 23½ per cent. in London, it will be seen what a large sum will be set free for provident saving in other directions, if, by means of these societies, working men could generally become their own landlords.

4. *Trade Unions.*

Trade Unions, when the Combination Laws were first repealed in 1824 and 1825, and for long after, were almost entirely organisations fighting for better terms to Labour, but they have now changed their character to some extent, and while maintaining the original aim, have become benefit societies, giving sick benefit, funeral benefit, and, what peculiarly entitles them to a place in this enumeration of thrift agencies, superannuation benefit when incapable of work. Out of 583 registered Trade Unions in the United Kingdom in 1893, 543 sent in returns of their membership and funds to the chief Registrar. The following figures do not include the 40 registered societies that failed to make returns, or the large number of unregistered societies, which may amount to half the number of the registered ones. There were 1,080,465 members, and the total annual income was £1,790,197; these figures compare with 249,653 members and an annual income of £358,286 ten years earlier. The old-age pay in most of these Unions runs from five shillings to eleven shillings per week. Looking at the large and increasing number of men who pay in order to receive this benefit, we may conclude that through the Trade Unions there will be in future a considerable decrease of the number of men who seek relief in old age.

5. *Co-operative Societies.*

The Co-operative movement is another form of self-controlled association which up to a comparatively recent date was handicapped by legal barriers which have now been swept away, and the extension of which within the last forty years has been truly marvellous.

At the beginning of 1862 there were said to be in existence fifteen retail co-operative societies, with 48,148 members, a capital of £336,290, and turning over £1,512,517 a year.

At the beginning of 1895 there were in existence 1484 retail societies, 175 productive societies, and two wholesale societies, with 1,343,518 members and a capital of £19,391,347, and yearly sales amounting to £49,985,065, with yearly profits amounting to £4,911,299, without reckoning interest on the capital.

In thirty-three years the number of members has been multiplied 28 times; the amount of trade 33 times, and the amount of capital 57 times; while the annual profits are now three times greater than the total sales in 1862 and fifteen times greater than the total capital at the same period.

Such Societies, which are another creation of the Victorian era, have conferred great benefits on the working classes. Among these may be enumerated the payment for goods in cash with periodic bonuses on the amount of purchases, and facilities for saving money at a fair rate of interest.

6. *Friendly Societies.*

Friendly Societies, the last of the forms of voluntary association to which I shall refer, have become so influential a force in the national life that no Government would care, or dare, to introduce legislative proposals affecting the welfare of the people in times of sickness and of old age, without their co-operation and approval. The Registrar-General in his Report states the membership of these societies to be 8,320,262, with funds amounting to £26,003,061; but these figures include Collecting Societies and some other societies which can scarcely be properly described as Friendly Societies. The best form of Friendly Society is the Society with branches, better known as the Affiliated Order. Of these there are on the Register, including branches, 28,584, of which 23,998 made returns, showing a membership of 4,203,601, with funds amounting to £22,695,039.

It would be impossible to speak too highly of the benefit these societies bring to the families of the working classes, and of the good they do to the nation. The late Mr. Tidd Pratt computed, nearly a quarter of a century ago, that these societies saved the nation in poor-rates no less than £2,000,000 annually. With the great advance that has since taken place in the development of these societies, it is not unreasonable to estimate this saving at the present time to be over £3,000,000. Both Mr. Brabrook, Chief Registrar, and Mr. Sutton, Actuary to the General Registry of Friendly Societies, are of the opinion that the work of the friendly societies has had much to do with the diminution of pauperism since 1834. It was pointed out to these societies by the actuaries, that the feebleness arising from old age cannot be considered as sickness provided for in the contributions charged, and this has led to the formation of tables with rates which allow the additional benefit of pensions in old age, on participation in which sick pay will cease. It is very seldom that a man who is a member of one of these societies seeks poor relief in any way, and it will be still more rare if this old-age pension benefit becomes generally adopted.

Some of the lodges of the Independent Order of Oddfellows (Manchester Unity) make it compulsory for their members to subscribe for an old-age pension along with the other benefits. This Society has a membership of 876,655, with funds amounting to £8,754,754. It received last year, for contributions, interest, etc., £1,520,365, and paid for sickness and other benefits £1,184,101. The Grand Master of this Order, in speaking of the subject of State aid for old age at the conference in Bristol this year, said :—"Depend upon it, the greatest enemies of the working "man are those who advise him to rest—to dissuade him

" from further practice of self-denial, and to inculcate the belief " that he has already made all the sacrifices of which he is able. " And long may the day be distant when the members of our " Order—the largest and richest Society in the world—shall be " led aside by such unhealthy and ill-timed assistance."

The Ancient Order of Foresters, at the conference this year at Dundee, after a long and animated discussion on this subject, passed by a majority of 328 to 56 the following resolution:— " That in the opinion of this High Court meeting, State Pensions " would be detrimental to the best interests of friendly societies."

This Order is the second largest in the Kingdom, having 723,329 benefit members, with funds amounting to £5,371,670. It received last year, from contributions, interest, etc., £836,300, and paid out for sick and other benefits £684,272. The membership has nearly doubled since 1870, while the Court and District funds have nearly quadrupled in amount.

Both the Oddfellows' and the Foresters' Societies are paying considerable attention to the formation of lodges and courts for females, and it is to be hoped that within a few years facilities will be placed within reach of the working women of the country, more especially in the large cities, to obtain the protection against many of the ills of life which these societies have so successfully afforded to men.

Since 1875, when an Act was passed making a valuation of assets and liabilities compulsory by these Societies, there has been great progress towards actuarial solvency; and though perfection has by no means been reached in this respect, there is no doubt that the financial stability of these great Orders, under competent actuarial advice, is well secured.

One advantage which has been gained by the marvellous success which has attended these Orders, is that other kinds of Societies, of a weak, evanescent, and unsatisfactory character, are rapidly dying out. These large Societies are managed with great rectitude and success, and in the courts and lodges throughout the country the working men are undergoing a process of education and business training, which inculcates the necessity of law and order, and will prove a bulwark against the impracticable schemes of Socialists and Anarchists.

We have now finished a survey of six of the outstanding associated efforts which operate, and will more largely operate every year in future, in the partial cure of old-age pauperism. Taken together, their invested funds amount to close upon £250,000,000, while they possess an enormous income, which is collected with great economy, the disbursement of which brings comfort and independence to countless homes.

This completes the statement in support of my third contention, viz. :—that sound thrift agencies have greatly multiplied and are now being much more largely taken advantage of by the working classes.

I have now stated three of the grounds on which my opinion is based, that it would be unwise to interfere with the present poor law provision for the aged poor, by endeavouring to substitute for it an expensive State pension scheme; but there are other reasons equally weighty, though of a different nature, which I would like to bring under notice, before treating of the various kinds of pension schemes which have been proposed. I have not time to refer to more than two of these, viz. :—

1st. That a study of the causes of Pauperism brings out clearly to what a small proportion of the aged poor pensions would be of any avail.

2nd. That ameliorations introduced in recent years in the treatment of the deserving aged poor have rendered their lot more comfortable under the poor law provision than it would be under the proposed pension schemes.

I refer first to

THE CAUSES OF PAUPERISM.

Mr. Charles Booth, in his notable book on Pauperism and the Endowment of Old Age, gives the following lengthy list of the principal causes :—

Crime.	Extravagance.
Vice.	Lack of Work.
Drink.	Trade Misfortune.
Laziness.	Restlessness.
Pauper Association.	No Relatives.
Heredity.	Death of Husband.
Mental Disease.	Desertion.
Temper.	Sickness.
Incapacity.	Accident.
Early Marriage.	Ill Luck.
Large Family.	Old Age.

In the Stepney Workhouse, Mr. Booth puts drink as the direct cause of Pauperism in 12·6 per cent. of the cases, and the contributory cause in a considerable proportion of the other cases; out of 634 cases 165 are returned as affected by drink. This proportion is less than has been found to be the cause elsewhere. "Sickness and old age," Mr. Booth says, "are causes so over-

"whelming and obvious as to draw a curtain over what has gone "before; behind that curtain we doubtless might find some whose "previous life offered another explanation of their condition."

In the St. Pancras Workhouse the pauperism traceable directly to drink he puts at 21·9 per cent. In that workhouse, drink, sickness, and old age stand about on an equality, both as principal and subsidiary causes, differing from the Stepney causes, in which drink is much less prominent. The part which drink plays amongst the more permanent paupers is less than amongst the current cases, and very much less than with the "ins and outs," of whom over 40 per cent. stand with drink as the principal cause. Councillor Alexander M'Dougall, Vice-Chairman of the Manchester Board of Guardians, inquired into the causes of 254 cases, including epileptics and lunatics, of whom 120 were outdoor and 100 indoor, besides cases in lock and vagrant wards, and the conclusions he arrived at were that pauperism caused by old age or infirmity, without any discredit, explained nearly one-eighth of the pauperism of the township; pauperism by disease (not brought on by misconduct), or accidental injuries involving inability to work, accounted for one-seventh; drunkenness explained 51·24 per cent.

It is probable that the extent to which, throughout the whole country, pauperism is caused by drunkenness, lies midway between the figures of Mr. Booth and those of Mr. M'Dougall. This points to some action on the part of the Legislature being advisable to reduce the facilities for drinking. Public-houses are too numerous, especially in the large cities, in close proximity to the houses of the working classes. It is clear, therefore, that the poor-houses are the resort in old age of a large mass of men and women who are the victims of drink, and to whom pensions would be of little avail.

Mr. Loch says:—"Pauperism due to old age or infirmity, or "disease or accidental injuries, as above defined, forms roughly a "fourth of the mass of pauperism, and might possibly be affected "by the establishment of an annuity system."

Another prolific cause of pauperism is mental disease. Mr. Booth states the proportion in the St. Pancras Workhouse as only 4·3 per cent., but qualifies this figure by stating "that such cases after a while pass into the lunatic or imbecile asylums." It is impossible to assess the ratio by which pauperism is affected by lunacy, as the material is insufficient on which to base a calculation; but one very eminent authority, who is an acute and careful observer, places the ratio as high as 19 per cent. Another thing to be borne in mind is that if a man, earning even £2 or £3 per week, becomes mentally afflicted, the chances are that he has not saved enough for his support in an asylum, and so he becomes dependent

on the provisions under the Poor Law, and very often his wife and children become dependent also.

Laziness and immorality are put down by Mr. Booth as contributing 16·15 per cent. of the existing pauperism in the St. Pancras Workhouse.

This bird's-eye view of some of the causes that operate to fill our workhouses is intimately related to the problem of old-age pensions. These people, for the most part, have not been taught to be the intelligent guardians of their own health and conduct. What they need is not pensions—it is guardians. They require to be guarded against themselves, and this can only be done by the indoor accommodation which the State provides.

It is well to bear in mind, when we hear people advocating a system of old-age pensions for the poor in order to remove the stigma of pauperism, that the great majority of Paupers, from the causes which have brought them under the Poor Law, are utterly incapable of deriving any benefit from a pension scheme.

AMELIORATIONS IN TREATMENT OF THE AGED POOR.

I shall now say a few words as to the ameliorations in the condition of the aged poor which have taken place of recent years. The treatment is not now what it used to be, though the sound principle is maintained that the aliment and general comfort should not be of a superior kind to the aliment and general comfort of the independent labourer of the lowest class. Old couples are not now separated if they wish to live together. There is now in most workhouses careful classification of the deserving and worthy poor, as distinct from the dissolute, depraved, and unworthy. There is nothing which so completely removes the *raison d'être* of the grievance which has created this temporary old-age state-pension craze as the movement which has set in for the classification and better treatment of the deserving aged poor. I call attention to it specially because none of the writers on the subject have given it the emphasis to which I think it is entitled. I cannot give a better illustration of these various alleviations than by bringing under your notice the report by a Committee of the Edinburgh Parish Council issued this month, which is given as an Appendix[1] to this paper. The aged sick poor are treated in hospitals and attended to by qualified nurses. The ameliorations which have been extended to the bodily sick and infirm have been shared to even a greater extent by the mentally afflicted.

[1] See Appendix, page 30. These recommendations have now been adopted by the Edinburgh Parish Council. I invite special attention to them.

It may be hailed as a happy omen for the comfort of the women and children, that ladies are finding a place on many Boards of Guardians, and that they gladly give their time and talents, and grudge no service by which the lot of the poor may be brightened and made more comfortable. Our Poor Law system is not perfect; there is need of further reforms in various directions, but if it has not yet become what it ought to be, there is this to be said for it,—there is no country in Christendom where the provisions of the Statute Law are more kind and humane. The national conscience is not dead to the obligations of humanity and religion, though it might be more alive than it is. We see everywhere organisations springing up to supplement with wise and well-directed charity the provisions of the Poor Law, and to carry out many schemes for the alleviation of the lot of the poor. This is the reason that many of the pension schemes which have been proposed in recent years have received so much attention and favourable consideration.

SCHEMES OF OLD AGE PENSIONS.

Compulsory Schemes.

The adoption by Germany of the Law of Insurance against invalidity and old age, which passed the Reichstag on 23rd May 1889, was the chief means by which the subject of State pensions was brought into prominent notice, and elicited the inquiry if what was good for Germany would not be good for this country.

We may well put the previous question, "Is this law really good for Germany?" There is no doubt that this scheme was introduced by Bismarck for political purposes, viz., to take the wind out of the sails of the Socialists, who, becoming strong in their numbers, were also becoming loud in their protests against the oppression and hardships produced by militarism and protection.

The main features of the German scheme are that it is compulsory, and that the contributions for the scheme are paid concurrently by the insured, his employer, and the State. The annual allowances range from £5, 14s. 8½d. to £20, 15s. 6d. for invalidity, and from £5, 6s. 5d. to £9, 11s. for old age. There is an excellent account of the scheme in the Journal of the Institute of Actuaries for July 1891, by Mr. T. E. Young, in which he gives full details of the vast machinery necessary to administer this scheme, with an admirable criticism of its provisions and tendencies; and what strikes one most on studying the great complications of the procedure which he describes are the comparatively insignificant results that are attained by it. Already there are ominous mutterings of discontent at the measure. The truth of Mr. Goschen's words at the time it was introduced is only too apparent. He said: "I

" want to point out one of the cardinal dangers of the system of " compulsory insurance in its bearings on Socialistic projects. It " means regulation, and regulation of labour as a whole. You " cannot have a system of compulsory State-aided insurance with- " out depriving working men of liberty and many privileges which " they enjoy."

The working men of Germany, as well as many of the masters, are crying out against the bureaucratic interference over every branch of industry which those whose duty it is to administer the system affect. Malingering has made great strides in both the accident and invalidity departments of the scheme, so that the Imperial Insurance Office has heavier claims to meet than previous experience indicated; the increase of litigation has been enormous, while the costs of administration of the scheme have exceeded the original estimates to a large extent.

The scheme has certainly not made for social peace, and thus the experience of Germany offers little inducement to this country to follow its example. Even, however, if the experiment had been everything that its most sanguine friends predicted, we would not have been justified in entering into a similar scheme. As Vinius says: " A diversis nulla illatio est." The circumstances of the two countries are entirely diverse. In Germany the State affects to do for the people what in Britain the people have learned to do for themselves. The German people are dragooned into obedience to what the State is pleased to think good for them, whereas in Britain, where freedom " has slowly broadened down from precedent to precedent," the people are proud of the privilege and responsibility of their vocation to be the originators and the guardians of their own schemes of thrift.

The indications of feeling are that no scheme of a compulsory nature would have the slightest chance of being adopted by the people of Great Britain on account of the compulsory element alone, although possessing otherwise some elements of attraction.

The typical scheme having the compulsory element as its basis has been that of Canon Blackley, who brought to bear an amount of volcanic energy and eloquence in its promulgation, that for a time arrested the attention of the nation. Briefly put, the scheme at first required that a contribution of £10 be provided by the assurer himself between the ages of 18 and 21 years, which sum accumulated at 3 per cent., it was calculated, would yield a pension of 4s. per week on the attainment of age 70, and an allowance in sickness from the first of 8s. per week. Mr. Sutton and other actuaries in their criticisms of the scheme stated that, without calculating the costs of management, the contribution proposed was only sufficient to yield the benefits promised to the extent of 52 per cent. of their amount. The Friendly Societies protested

against the State entering into the business of Sickness Assurance, which field they already occupied so efficiently, and so apart from its initial blemish of compulsion, there were other good reasons why this scheme should be relegated to the bourne of unpractical proposals.

Voluntary Schemes.

Following this scheme there came a host of other schemes of a voluntary nature, but to which the State was to grant aid, so as to make this form of thrift—the purchase of deferred annuities—of easier accomplishment than formerly to the great mass of the people. Of these proposals Mr. Chamberlain's scheme has most fully and longest held the field, though recent indications point in the direction that its inherent unsoundness has been found out. Mr. Chamberlain's proposals have been of a singularly chameleon-like character, endeavouring by a ready adaptivity to overcome economic and actuarial defects as they became apparent, and to win the approval or overcome the objections of the greatest number of the people.

The latest proposals appear to be,—briefly stated,—that the State is to guarantee a pension of 5s. a week at age 65, and if a man dies before the pension age his widow would receive 10s. a week for six months and his children 2s. a week if under 12, until they reached the age of 12, provided always that the weekly sum paid to any single family did not exceed 12s.; and that the voluntary payments by the beneficiaries themselves would be a lump sum of £5 before age 25, and subsequent payments of £1 per annum until the attainment of the pension age. The State aid is to be given in the form of a lump sum of £15 credited to each assurer when he pays his £5, and these two sums and the annual contributions are to accumulate at 2½ per cent. compound interest until the age of 65, when the survivor will be the happy recipient of an annuity guaranteed by the State of £13 per annum. Another proposal is that the deferred annuity pure and simple, without other benefits, would be secured by a single payment of £2, 10s. before age 25, and the payment of 10s. a year from age 25 to age 65. In this case the State subsidy proposed is £10.

To allay the opposition of the working classes, and to induce them to become more cordial towards this scheme, further proposals have been made for adding the State subsidy to deferred annuities obtained through Friendly Societies and Trade-Unions. Some members of these societies are not averse to entertain these proposals, on the clear understanding that if they open their mouths the State will close its eyes and not inquire into what they are doing with the money, or into their financial ability to perform their contracts. These are conditions which are not likely to be

complied with. The State, if contributing, would be bound to institute a system of inspection and supervision, and so these societies might bid farewell to the independence and self-government which they cherish so proudly. Apart from this Friendly Society medium the proposals have not sufficient attractiveness to warrant the hope that they would be adopted by a sufficient number to make the scheme successful. The Friendly Societies can already offer nearly as good terms for deferred annuities as would be secured under the State-aided scheme. The larger rate of interest obtainable by the voluntary agencies, over what the State guarantees in its scheme, is very nearly equivalent to the benefit derived by the State subsidy.

The Manchester Unity of Oddfellows some time ago published a table of contributions required to secure a superannuation benefit of 5s. per week after the age of 65. At age 25 the contribution required is 5½d. per week if the contributions are to be returned in the event of death before 65, and 4d. per week if they are not to be returned. These agree very closely with the rates of contributions prepared by Mr. Sutton in connection with the School Board for London Superannuation Bill. The above-quoted sums, however, are exclusive of expenses of management, and if we add, say, 10 per cent. for these, they become 6d. and 4½d. respectively. The Post Office charge about 9d. and 5¼d. respectively for the same benefits. The former figure is much higher than that of the Oddfellows—about 50 per cent.—the principal reason being, that the contributions are returned on application before the annuity becomes payable as well as in the event of death. It should be kept in mind that in the unlikely event of Mr. Chamberlain's scheme being widely adopted, the taxes necessary to meet the cost of the proposed State subsidy, and the cost of administration of the Scheme, would be very heavy. Mr. Chamberlain, in his evidence before the Royal Commission for the Aged Poor, said that he did not think that any practical Statesman would be able to contemplate a larger expenditure than £2,000,000 a year for a State-aided pension Scheme, and he suggested that this sum would suffice to carry out his scheme, but the Committee who reported upon it were of opinion that a larger sum would be required. From calculations I have made I estimate that if every one aged 25 joined it, the cost to the State would be about £7,000,000. If only the industrial classes took advantage of it, the cost would fall to £4,500,000, and a further sum of at least £500,000 would be required for administration expenses. A considerable proportion of this large cost would fall upon the industrial classes in the shape of rates and taxes. Taking this further payment into account, the figures quoted indicate that the Friendly Societies will be able to give their members at least as

good terms as would be obtained from the proposed Chamberlain Subsidised Scheme, and in a more convenient and popular form. It may also be pointed out that the scheme would not benefit the present generation of men and women who are over 25 years of age, but they are to enjoy the privilege of helping to pay for the remote benefit to be enjoyed by the rising generation.

The purchase at early ages of deferred annuities commencing at age 65 is not popular with the working classes, nor indeed with any class of the community. The Post Office Savings Banks, in the last ten years, have only issued 1410 contracts of this nature, though their scheme has been widely advertised. The figures obtained from other quarters where efforts have been made to popularise this system of saving, give the same record of failure. It is extremely difficult to see the logic of granting a State subvention to a person who buys a deferred annuity, and not granting one to the person who purchases an endowment assurance policy—a much better form of thrift and a much more valuable hedge for the Nation against Pauperism.

There is thus a *prima facie* case that the voluntary scheme would not be taken advantage of by many people, and it is almost certain that if taken advantage of, it would be by people who would probably have bestowed their savings in the patronage of other forms of thrift. It would therefore, if successful, damage the existing thrift agencies of the people. The cost to the nation for the amount of benefit it would succeed in selling against the attractions of other agencies would be startling; while the extent to which it would accomplish the object in view—the reduction of old-age pauperism—would be fractional.

Universal Schemes.

It now only remains to refer to the last class of State pension schemes that have been proposed for the cure or amelioration of old-age pauperism, viz., schemes of universal application for the general endowment of old age, with which the honoured names of Mr. Charles Booth and Mr. Ralph Price Hardy have been specially identified.

The scheme which has received most attention, as coming from Mr. Charles Booth, who stands deservedly high as a thoughtful writer on the condition of the poor, is—briefly stated,—that each person on attaining age 65 should receive a pension of 5s. per week, to be met out of the funds of the State, no payment on the part of the beneficiary being required.

It has been said that this scheme has the merit of dispensing with all actuarial calculations, and that the liability of the State is ever known, or can be predicted with almost absolute certainty, but I think that a little consideration will show that this is not the case.

The immediate cost could easily be determined. The number of persons above 65 years of age at the last census in 1891, in England and Wales, was 1,372,602, and in Scotland 203,096, together 1,575,698. If the population remained stationary the net cost every year would be 1,575,698 multiplied by £13, or £20,484,074, exclusive of the cost of management. From this last, even suppose there would fall to be deducted the whole sum spent in outdoor relief at present, say £4,000,000, the sum left is sufficient to deter any Government from undertaking it; but it is well known that the population is not stationary, and the following figures for the last three censuses of persons above 65 years of age, corresponding to these given above, show how rapidly that population is increasing:—

	1871	1881	1891
England and Wales,	1,078,163	1,188,644	1,372,602
Scotland,	174,003	185,297	203,096
	1,252,166	1,373,941	1,575,698

It is obvious therefore that the sum mentioned above would gradually increase, although it is but fair also to bear in mind that there would be a larger number to bear the cost.

Here you have a gigantic scheme at enormous cost, to do for the people what at least four-fifths of the people are doing for themselves, and which, if done for the remaining fifth, would not meet the necessities of their case nearly so well as the present provision under the Poor Law.

I need not repeat the arguments which have been used throughout this paper against interference by the State, either in this wholesale or in Mr. Chamberlain's more retail fashion, but I cannot forbear giving you three of the conclusions arrived at by the Committee of the Society of Inspectors of Poor for Scotland, in a report issued by them in 1893 on the subject of Old-Age Pensions and Pauperism, in which some of the arguments above given are recapitulated. Their objections to such Pension Schemes as Mr. Booth's are as follows:—

a. "There would be no control or supervision, as at present "exists under the Poor Laws. The idle, dissolute, drunken, and "depraved, entitled to a pension, would drink or dispose of it as "soon as received, and be as destitute as ever; could move about "as they thought fit and defy all authority; there would be

" almost a licensed system of begging to all who cared to go on " the tramp. Without doubt, tramps would be more plentiful, " and the public more annoyed than at present. But the prin- " cipal objection to any of the Old-Age Pension Schemes is that " few of the paupers above 65 years of age chargeable, could " at any time of their history comply with the conditions laid " down by the authors of the schemes."

b. "It would largely tend to break the parental tie and liability " of children to support their aged and decayed parents, already " far too loosely carried out. Sons and daughters, who are now " forced by law to contribute to their support, would no longer " have any care or thought for their parents. As a writer " states:—'It suppresses the family, and weakens the natural " ' obligations, which, once loosened, are not easily bound up again. " ' It is the experience of every one who has closely studied the " ' habits of the people, that the parental obligation which springs " ' from the law of nature, to do the best that can be done for " ' children, is very universally repaid by the children to their " ' parents, when the latter are old and no longer fitted for the " ' battle of life.' To a recognition of this is due in a large " measure the fact that, in Scotland at least, the aged are so well " cared for, and that so few aged couples are found spending their " waning days in the poorhouse."

c. "That it is a libel upon the Poor Law administration of this " country to say that the decent, well-doing, aged man and wife " are huddled into the poorhouse to end their days. The reverse " is the case; it is the dissolute, drunken, and depraved, and " those who cannot take care of themselves outside, who are sent " to the poorhouse; while the hospital of the poorhouse is the " refuge of all."

These are the carefully-thought-out conclusions arrived at by a body of experts who have had long practical experience, and who know the circumstances fully, and they are therefore entitled to be received with respect.

Conclusion.

And now, Gentlemen, in conclusion, I hope that this address, loaded with statistics as it necessarily has been, and longer than I intended it to be, has not tried your patience too severely. I confess that I have only brought it within its present limits by omitting some points which might have made the argument more complete and convincing.

I trust that the discussion of the subject may have the effect of making each member of the Actuarial Society take a greater

interest in the deliberations and decisions of the Treasury Committee on this subject at present meeting in London.

I hope the final Report of the Committee will express a decided opinion that the industrial population can best make provision for old age by self-reliant efforts, such as they are now largely adopting, and not by State aid. As I write there has come to hand the following brief report of a meeting of the Committee held this month, to the following effect:—"The Committee discussed the numerous "schemes which had been sent in. They were inclined to think "that those which involved compulsory contributions (after the "German system), and those which involved a system of universal "free pensions, without any kind of contribution, or evidence of "thrift on the part of the beneficiaries, were not within the scope "of the reference."

This clears the ground, and limits the reference to Voluntary Schemes.

The national interest which has been created in this question will be of immense advantage if it leads the able and large-hearted men who have given so much time and trouble to planning State-aided pension schemes—seeing that help does not lie in that way—to devote their talents and influence to the encouragement and betterment of the existing voluntary thrift agencies of the people.

If the members of the Society, who in this community exercise a great influence, adopt the views I have advocated, I feel sure that much good will be accomplished in this direction, and I also feel sure that they will not thereby show less sympathy or take a less interest than they have done, in trying to do what they can to help, to comfort, and to relieve the aged and the suffering poor.

APPENDIX.

REPORT BY COMMITTEE OF EDINBURGH PARISH COUNCIL *on Classification of the Inmates of Craigleith and Craiglockhart Poorhouses, irrespective of Hospital Patients, Children, and Lunatics.*

AT the ordinary meeting of the House Committee of the Edinburgh Parish Council, held on Monday, 4th May 1896, a Sub-Committee was appointed to inquire into the subject of Classification.

The Committee elected to serve in this matter have taken much trouble, and have made wide inquiries on this subject. They have visited Dundee and Glasgow, where a certain measure of classification is carried out. They have written to all the Poorhouse Governors in Scotland (66 in number), and have received replies from 60 of them. In 29 Poorhouses no classification is attempted, most of the others are either making experiments in classification, or are desirous of doing so, but some can do nothing for lack of accommodation. Your Committee feel that, in Edinburgh, we are in a favourable position for trying something, as the Council is in possession of two Houses, and thus able to carry out entire separation. Classification, other than what is at present followed out, must in one House prove a failure. Nothing but discontent would be the result, but the hope of promotion to a better House would, the Committee trust, remove in some measure the popular aversion to the word "Poorhouse," and bring a ray of sunshine into many a hopeless life. If Edinburgh succeed in this attempt it may be that its good example may be followed throughout Scotland.

Further, Councillors, Inspectors, Governors would thus, *i.e.* having two Houses, have it in their power to carry out a system of testing which may have a good effect in diminishing pauperism, and calling out the unused powers of the idle and vagrant to support themselves.

The inmates of our Poorhouses are at present, roughly speaking, arranged in two classes. *Firstly.*—The sick; the aged and infirm; children. *Secondly.*—Test cases, namely—the dissolute, deserted wives, and men or women whose families ought to support them.

We take for granted that persons whose character and history would entitle them to be called "respectable," but who, through no fault of their own, are in receipt of parochial relief, receive that relief outside the House. For various reasons, however, some of these people find their way to the Poorhouse. There are also in the House inmates who, from the guarded life they lead there, and through being removed from their evil surroundings and temptations, show a change of character, which in some cases entitles them to be viewed and treated as reformed.

A strong feeling has arisen all over the country that *Class I., i.e.* aged and infirm, those who have been ratepayers, and those who have led respectable lives, or who show evident signs of moral improvement, deserve consideration, and that they should, as far as possible, be separated from persons of a vicious character, and be also furnished with some extra comforts and

privileges. That such consideration is to be shown would surely have a salutary effect both in and outside the Poorhouse.

The Committee therefore submit the following proposals for the consideration of the Council:—

Firstly.—That Craigleith should be chosen as what we might call the "privileged" House,—Craiglockhart being in every way more fitted to be the test House.

Secondly.—The privileged classes to be—

(1) The aged and infirm.
(2) Children who are to be boarded out.
(3) Wives (and children) deserted through no fault of their own, and not considered suitable for out-door relief.
(4) Maternity cases whom it may be considered desirable to send to Craigleith.

The Committee have named the "aged and infirm" as a class, but it is well known that many of those whose age would entitle them to extra comfort are yet by their conduct and language unfitted for the better House. The Committee are anxious to give them every chance and inducement to do better, and they therefore propose to place them in Class I. Should, however, any of the inmates of the Privileged House indulge in any unbecoming conduct, they would, when this conduct is reported to a Relieving Committee or to the Members of the Council paying an official visit to the House, be liable to be at once transferred to the Test House, namely, Craiglockhart. It is not proposed to disturb the old people who may have been for many years in Craiglockhart, and unwilling to remove, but if a beginning were made the end in view would gradually be accomplished. Doubtless there will be considerable difficulty in making selections for the Privileged House. Age pure and simple cannot always, as we have shown, be accepted as a qualification, neither on moral nor physical grounds; much of the work of the House being done by aged women, and of course each House would require a certain number of able-bodied men and women to do the work of the House. The fairest way would seem to be to take into consideration age, good conduct in the House, and such knowledge as the Inspectors can acquire of the applicant's previous history. This, with the discriminating powers of the Relieving Committees, and the testimony often sent by ministers and others, should do much to make the scheme practicable.

Thirdly.—Privileges—

(1) Day Rooms—Separate day rooms to be provided.
(2) Visitors twice a week; greater facilities for visiting and receiving visitors, subject to the discretion of the Governor; and to be allowed to attend their own places of worship.
(3) Clothing—Improvements in clothing.
(4) Diet—Greater variety in diet, to be afterwards fixed by House Committee.

At present the aged and infirm women who are unable to go down to the hall for meals, eat, sleep, sit, or lie in bed night and day in the same rooms, and are never away from each other. This must be great thraldom, and we propose that each floor should be provided with a day-room, where the old women might move about and find either more liveliness or greater quiet; and where those able to walk could dine, read, or work, and thus bring some variety into lives that may have had little to brighten them, and that will probably ere long end in the Hospital.

In these rooms there might be some pieces of carpet, footstools, easy-

chairs, and small tables. There might too be some small cupboards where the old people could keep their few possessions. It would remain for the Councillors in visiting the Houses to suggest any other alleviations that might occur to them as proper.

The Governors and Inspector have greatly aided the Committee by giving exhaustive statements and statistics according to their knowledge of the inmates.

The Councillors will observe that the proposed changes can be effected at little expense; they do not interfere with the structure of the buildings, and only require some planning and contriving in the internal arrangements.

We append, for the information of the Council, the statistics by which the Committee have arrived at the proposed classification. They will see from this Table that Craigleith would have 251 inmates, as against 333 at present; and Craiglockhart, the Test House, 321, as against 239 in October 1896. This discrepancy would be sure to right itself when the selection comes to be made. In Craigleith there were in October of this year six married couples, three of them aged, but only one was recommended by the Governor to be placed in the first-class. The Committee trust that the Council will give the proposed arrangement for the two Houses a trial. They feel sure that they will thus fulfil the instructions of the Local Government Board, "that Class I. should be retained in the Poorhouse by kindness, and that Class II. should be repelled by strict discipline and the deprivation of indulgence." In one House we find "intemperate" marked against the name of 115 of the inmates, which shows the necessity for following out the advice of the Board. We earnestly hope that a year hence it may be found that kindness on the one hand and firmness on the other may prove beneficial to the poor, the ratepayers, and the country at large.

MARY CARR LEES,
Convener of Classification Committee.

29th October 1896.

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On an Investigation into the Mortality of the Married Females of the Peerage

BY

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OF THE SCOTTISH EQUITABLE LIFE ASSURANCE SOCIETY

On an Investigation into the Mortality of the Married Females of the Peerage.

(*Read before the Actuarial Society of Edinburgh, 6th December* 1894.)

In July 1880 there appeared in the *Journal of the Institute of Actuaries* certain "Remarks as to the Influence of Marriage on the Death-Rates of Males and Females, abridged from Dr. James Stark's Letters to the Registrar-General of Births, Deaths, and Marriages in Scotland" (*J.I.A.* xxii. 233). In these letters Dr. Stark compares the mortality of the married and unmarried females at different ages in Scotland in the years 1861 and 1862; and calls attention to the fact, that the excessive mortality of the former, as compared with that of the latter class of lives, appears to be confined to the ages under thirty years. He offers, as an explanation of this, the great danger—well known, as he says, to every medical practitioner—which attends the delivery of the first child; and then proceeds to demonstrate its effect by means of two tables, showing (1) "the number and ages of mothers and the number of children which they had on the birth of their last child," and (2) the "proportion of mothers bearing their first child to every 100 mothers." The figures given in the former table show that nearly as many women above thirty years as under that age bear children; and yet the marked difference between the mortality of the married and unmarried is only apparent below that age. From inspection of the second table, which shows the number of mothers bearing their first child to be, after age thirty, very small as compared with those under that age, he concludes that not only is the view that the risk to the mother is far greater at her first confinement, than at any subsequent delivery, rendered almost a certainty, but that the increased mortality of the married females is almost solely due to this cause.

An analysis of the practice of Life Offices with regard to female lives will be found in the *Journal* of the Institute, volume xxix. p. 75; and, from a perusal of this, it will be seen how differently they deal with this extra risk. A few provide for it directly by charging 20s. per cent. on marriage, or 10s. on first confinement, or a single premium varying according to the duration of marriage;

others by charging 5s. per cent. per annum, either throughout the duration of the policy or ceasing at age fifty; while many charge no extra at all.

At the suggestion of Dr. Sprague, I have investigated the mortality of the married ladies of the peerage, in the hope that such an investigation may not only shed further light on this important question, but prove useful in other ways. I have to thank Dr. Sprague for not only suggesting the principal lines on which such an investigation should be carried out, but also for giving me the benefit of his advice on various points that arose from time to time.

Of the various works which contain particulars of titled families, in only one, namely Lodge's *Peerage*, are to be found the dates of birth of the ladies of that class. This was, therefore, the principal source from which the data were extracted; but I had, in many cases, to refer to other works for dates that were not given in "Lodge."

As an Insurance office is sometimes asked to accept as evidence of age the particulars given in the *Peerage*, it may be useful to mention one or two points, which show that too great reliance must not be placed on the correctness of the dates found there. In several instances, in course of comparison of the dates of birth and marriage to obtain the age at marriage, the inaccuracy of one or the other was evinced by the abnormally low age at which the lady was apparently married. For example, in one case the life was stated to have been born in May 1843, and married in March 1857—that is, when she was only in her fourteenth year. As I learned from the editor of Lodge's *Peerage*, that he depends entirely on the information supplied by the families themselves, and has no other source of information beyond this, I wrote, in the case referred to, to the present holder of the title; and he informed me that the correct date of birth should be 25th August 1837, making the lady nineteen years of age at marriage. Again, in some instances, an obvious misprint was easily detected at the same stage of the inquiry. For example, a lady was stated in one edition to be born in the year 1800, and married in 1814; but, on investigating other editions, I found that the latter date was a misprint for 1841, the age at marriage thus being forty-one instead of fourteen. Again, a person would be said to be born in the year 1748, where it would be obvious from the dates of birth of the other members of the family that the correct year must be 1784. These are examples of the sort of errors that are brought to light by a careful examination of the work.

In dealing with the very numerous cases where the date of birth was wanting, it may be useful to mention that it was generally possible, by an inspection of the adjacent dates of birth, to obtain a close approximation to the true date. For example, suppose a

member of a family is stated to have been born on 20th October 1784, and his next younger brother on 19th January 1788, then the year of birth of a sister, who came between the two, and whose date of birth was not given, may fairly be taken as 1786 without involving much error. The date of marriage, too, was often not given in "Lodge": in such cases Foster's *Peerage* proved very useful. The compilers of the latter work have not apparently been content with inquiring only of the families themselves on this point, but have obtained elsewhere the required dates, when not forthcoming from the usual source.

The next point to be considered was as to the extent of the data to be employed. Taking the edition of the *Peerage* for 1887, I wrote cards for all the married ladies who were of the following relationships to the then holder of the title, viz.: (1) his daughters, (2) his sons' daughters, (3) his sisters, (4) his brothers' daughters, (5) his father's sisters, (6) his father's father's sisters. Wives were not included unless they appeared again under their maiden family name. In Lodge's *Peerage* each male member of a family appears in his order of succession to the peerage; the names of the sisters of each being placed in their proper order. The above classification represents, therefore, in most cases, the order in which the female members of the principal branches are to be found, and includes the names of most, although not all, the ladies to be found in one volume. There are, in addition, some who have married members of the peerage class, but who, not being by birth of titled family, do not appear under their maiden family name; also, under the heading "collateral branches" are recorded the names of more distant relations than those I have mentioned. I considered, however, that the observations would be numerous enough for the purpose without these: they could be included without much trouble if it were necessary at any future time to supplement the experience.

For such a purpose as the present, it is of course essential to carefully consider the method adopted in the compilation of the work from which the particulars are to be extracted; to see that no form of selection is allowed to disturb the conclusions to be drawn from an examination of the experience; which disturbance might result from either the omission of certain of the sections of lives given above, or from the inclusion of a few, the record of whose names depended specially on their survival to a certain date. For example, in many cases the names of the peer's father's sisters were omitted altogether from the section relating to his family, or sometimes only the "surviving aunts," as they were designated, were mentioned. It was clear that, in such cases as these, it was necessary to refer to preceding volumes to obtain particulars of those who died earlier. Again, where the peerage is of recent creation, only the names of the peer's daughters, or grand-daughters, are

recorded; but the necessary omission in such cases of his other relations would not cause any disturbance.

I found that, by restricting the data to the particulars in one volume, the time for which a large proportion of the lives would be under observation would be rather too short. To remedy this, all those existing at 31st December 1886 were continued under observation till 1892, if existing at that date, or to the date of their death, if it occurred previously. I did not consider it necessary, however, to include any further marriages.

I have described somewhat fully the various points to be considered, and the errors and omissions to be guarded against, in employing such a body of facts as that contained in the *Peerage*, as the recital of them may not only be of service to any one undertaking a similar investigation, but may also be useful to those who have to consult the volume for other purposes.

In the present instance I have followed the example of Dr. Stark, and considered simply the mortality of females, who have married, without regard to whether they were still married at the time of their death or had previously become widows. It was pointed out, in an editorial note to Dr. Stark's paper, that the inclusion of widows would disturb the conclusions as to the mortality attendant on child-bearing. But in the earlier years after marriage, at any rate, where these bear a very small proportion to the total exposures, the principal features of the mortality cannot be appreciably affected.

The number of lives included in the experience was 2014, of whom 1104 were existing, and 910 had died; and the total number of years of life was 58,822. The method of tabulation adopted was that recommended by Dr. Sprague in his paper, recently read before the Institute, "On the Tabulation of the Facts extracted from the Records of a Life Office for the purpose of investigating its Mortality Experience." (*J. I. A.* xxxi. 205.) The commencing age, or age at first marriage, was the age at their nearest birthday. Where the date of marriage happened to be exactly equidistant between two birthdays, so that the exact age was $x+\frac{1}{2}$ years, the commencing age was taken as the difference between the years of birth and marriage. When the year of birth or year of marriage only was given, the birthday or the date of marriage was assumed to be 1st July; so that the commencing age was the difference between the years of birth and marriage. The duration was in all cases taken to be an integral number of years. In the case of the Existing, the observations closed on the anniversaries in 1892 of the dates of marriage; and all, therefore, were really under observation for an integral number of years. In the case of the Died, the duration was in all cases $n+1$, where n is the integral number of years since marriage. When the year only of death was given, it was assumed to have taken place on

1st July. But where the years only of death and marriage were given, and n is the difference between those years, the duration was taken alternately as n and $n+1$. The following table gives the number of marriages at each age up to age 60, and the deaths that occurred in each year for fifteen years after marriage :—

TABLE I.

Age at Marriage x	No. of Marriages at Age ε	Number of Deaths in Year.														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	3	...	...	1	...	...	...	..	...	...	...	...	...	...	...	...
7	24	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...
8	83	...	...	...	...	...	...	...	1	1	1	3	1	1	...	2
9	140	...	...	...	...	1	1	...	...	2	...	...	...	...	...	..
20	177	1	2	2	1	...	2	1	1	2	2	1	...	1	2	1
1	191	1	2	...	1	2	3	...	...	2	2	1	...	4	2	1
2	173	...	3	4	...	2	2	1	2	2	1	2	1	...	1	...
3	174	4	...	1	1	3	2	...	2	...	2	2	1	1	3	...
4	169	3	1	1	2	1	1	...	3	1	5	1	...	...	...	1
5	136	1	1	...	1	...	1	...	...	...	...	...	3	1	2	1
6	133	1	1	...	2	1	1	...	2	1	...	1	...	1	1	3
7	100	...	1	1	1	3	...	...	3	2	2	1	..	...	...	1
8	97	2	1	2	2	1	1	1	1	1	1	...	...	...	...	2
9	77	...	1	..	1	...	1	1	3	...	...	...	...	...	1	1
30	51	...	1	...	...	...	1	...	1	...	1	...	2	1	...	...
1	49	...	1	1	...	...	1	..	...	...	...	...	...	...	...	1
2	41	...	1	1	...	2	...	...	1	...	...	...	1	...	...	...
3	33	...	..	...	...	...	1	...	...	...	1	...	...	..	...	...
4	31	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...
5	18	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...
6	14	...	...	1	...	1	...	...	...	...	...	...	...	...	...	...
7	21	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...
8	9	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...
9	11	...	...	...	...	...	...	1	1	...	...	...	...	...	...	1
40	12	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...
1	15	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...
2	3	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...
3	7	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4	4	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...
5	3	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...
6	5	...	...	...	...	...	...	...	...	...	...	..	...	1	...	...
7	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
50	2	...	...	1	...	...	...	...	...	...	...	...	...	1	...	...
1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3	1	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...
4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
6	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
7	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
60	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	2013	14	19	18	13	19	18	5	21	14	20	15	9	13	12	15

It will be seen from the above, that the greatest number of marriages occur at age 21, and that a rapid diminution takes place after age 28, only 25 per cent. of the total number occurring after that age. Comparing the distribution as to age with that of the general population, we observe from the following table that the spinsters of the peerage class appear to marry at rather later ages than among all classes.

TABLE II.

Age.	Percentage of Total Marriages.	
	Peerage.	England, 1881.
16-18	5·4	6·2
19	6·9	9·0
20	8·8	11·0
21-24	35·0	43·7
25-29	26·9	20·0
30-34	10·1	5·8
35-39	3·5	2·3
40	3·4	2·0
Totals,	100·0	100·0

Perhaps the most important use that can be made of this investigation is to ascertain to what mortality a female, married at a certain age, is subject from the time of her marriage onwards. And, in the first instance, I shall show how the risk is affected by the time elapsed alone, apart from any change that may be due to increased age, by taking lives of the same present age, and comparing the risk to which they are exposed, according as they have been married one, two, three, etc., years. This can be most conveniently done in the manner adopted by Dr. Sprague to ascertain how the rate of mortality of assured lives is affected by the duration of assurance (*J.I.A.* xv. 334); namely, by tabulating the Exposed to Risk and Deaths for each age at marriage and each year thereafter; and then, having calculated the Expected Deaths by a table exhibiting rates irrespective of the duration of married life, by comparing the ratio of Actual to Expected Deaths at the end of one, two, three, etc., years after marriage. I employed for this purpose tables of the nature specified, computed from the present observations, and the H^F table. If the results obtained by the use of these two agree in their principal features, I think we shall be able to draw conclusions from them, upon which we may safely rely. By this means we can ascertain whether or not the commencement of married

life is attended with greater risk than subsequent periods; and from this conclude whether the first confinement is as dangerous as Dr. Stark would have us believe.

Columns 2, 3, and 4 of the following table give the Exposed to Risk, Deaths, and Adjusted Rates of Mortality, computed from the present observations :—

TABLE III.

Age.	Exposed to Risk.	Deaths.	Adjusted Rate of Mortality.	Rate of Mortality by			Age.	Exposed to Risk.	Deaths.	Adjusted Rate of Mortality.	Rate of Mortality by		
				H^F.	Peerage Females.	Peerage Males.					H^F.	Peerage Females.	Peerage Males.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
16	3	...	·0041	·0071	·0072	·0057		47,498	445				
17	27	...	·0040	·0071	·0076	·0065	58	808	10	·0147	·0207	·0223	·0211
18	110	1	·0039	·0069	·0078	·0077	59	784	17	·0154	·0218	·0237	·0222
19	249	1	·0038	·0067	·0080	·0089	60	752	9	·0166	·0237	·0252	·0235
20	425	1	·0037	·0069	·0081	·0100	61	725	9	·0178	·0259	·0268	·0253
21	615	3	·0042	·0073	·0081	·0108	62	696	10	·0194	·0285	·0287	·0276
22	785	4	·0052	·0079	·0082	·0114	63	668	19	·0211	·0314	·0308	·0303
23	955	9	·0061	·0088	·0082	·0116	64	630	14	·0241	·0345	·0331	·0335
24	1115	9	·0070	·0098	·0082	·0113	65	698	21	·0276	·0374	·0358	·0370
25	1241	8	·0076	·0108	·0083	·0108	66	559	17	·0318	·0402	·0386	·0407
26	1361	12	·0083	·0114	·0084	·0102	67	516	15	·0350	·0434	·0414	·0446
27	1444	12	·0090	·0118	·0085	·0098	68	485	18	·0387	·0470	·0443	·0487
28	1516	14	·0095	·0120	·0086	·0095	69	458	14	·0415	·0510	·0471	·0530
29	1563	16	·0096	·0120	·0088	·0092	70	428	26	·0436	·0556	·0498	·0575
30	1583	16	·0095	·0119	·0089	·0089	71	394	23	·0450	·0619	·0525	·0625
31	1602	14	·0094	·0117	·0090	·0086	72	363	9	·0470	·0692	·0553	·0684
32	1609	12	·0093	·0116	·0093	·0085	73	336	19	·0520	·0771	·0584	·0751
33	1607	20	·0092	·0117	·0095	·0084	74	307	18	·0590	·0858	·0619	·0827
34	1590	14	·0092	·0117	·0097	·0085	75	276	22	·0680	·0949	·0659	·0911
35	1567	10	·0091	·0118	·0101	·0086	76	243	14	·0790	·1040	·0704	·1004
36	1552	25	·0091	·0119	·0104	·0087	77	220	22	·0840	·1098	·0753	·1104
37	1521	10	·0091	·0120	·0107	·0089	78	190	22	·0900	·1151	·0806	·1211
38	1492	9	·0090	0122	·0110	·0092	79	161	14	·0960	·1193	·0859	·1325
39	1466	9	·0092	·0123	·0112	·0095	80	139	8	·1060	·1218	·0912	·1446
40	1442	14	·0093	·0125	·0114	·0099	81	123	14	·1180	·1236	·0965	...
41	1410	14	·0094	·0127	·0115	·0103	82	104	15	·1300	·1317	·1020	...
42	1365	16	·0096	·0129	·0116	·0107	83	83	12	·1460	·1453	·1078	...
43	1328	11	·0097	·0132	·0117	·0112	84	67	10	·1600	·1628	·1145	...
44	1301	8	·0098	·0134	·0118	·0118	85	55	15	·1760	·1856	·1223	...
45	1263	15	·0099	·0136	·0121	·0123	86	39	6	·1840	·2121	·1316	...
46	1220	17	·0100	·0138	·0124	·0129	87	29	2	·1980	·2370	·1426	...
47	1182	9	·0100	·0139	·0127	·0134	88	26	5	·2100	·2582	·1557	...
48	1151	12	·0101	·0140	·0131	·0140	89	20	5	·2200	·2726	·1705	...
49	1119	9	·0102	·0142	·0135	·0146	90	14	4	·2400	·2750	·1869	...
50	1089	6	·0104	·0145	·0141	·0151	91	9	3	·2700	·2690	·2049	...
51	1060	15	·0106	·0150	·0147	·0156	92	6	2	·3000	·2320	·2239	...
52	1020	10	·0110	·0156	·0154	·0161	93	4	...	·3300	·1797	·2436	...
53	987	11	·0114	·0164	·0162	·0167	94	3	...	·4000	·1857	·2642	...
54	953	16	·0120	·0174	·0172	·3174	95	2	...	·4800	·2086	·2850	...
55	903	14	·0127	·0183	·0184	·0182	96	2	1	·6000	·2562	·3060	...
56	866	9	·0134	·0191	·0196	·0191	97	1	...	·7600	·3377	·3263	...
57	841	10	·0139	·0199	·0209	·0201	98	1	1	1·0000	·5000	·3458	...
	47,498	445						58,822	910				

The rates of mortality in column 4 are those obtained after adjustment by the graphic method, and, for the sake of comparison, I have added in columns 5, 6, and 7 the rates of mortality according to the following tables, viz., H^F, Peerage Females, obtained by Messrs. Bailey and Day (*J.I.A.* ix. 305) and adjusted by Dr. Thiele (*J.I.A.* xvi. 43), and Peerage Males, obtained by Messrs. Bailey and Day (*J.I.A.* ix. 305) and adjusted by Dr. Sprague (*J.I.A.* xxi. 432).

I calculated then the Expected Deaths by the rates given in column 4 and the H^F table, and the ratios of these to the Actual Deaths. As would be expected, these ratios at individual years after marriage were too irregular to give any indication of a law; and it was necessary to group them before any conclusions could be drawn as to the way in which the duration of married life affects the death-rate.

The following table gives the results after grouping:—

TABLE IV.

Year after Marriage.	Exposed to Risk.	Actual Deaths.	Expected Deaths according to		Ratio of Actual to Expected Deaths.	
			Table III.	H^F.	(2) ÷ (3) × 100	(2) ÷ (4) × 100
	(1)	(2)	(3)	(4)	(5)	(6)
1	2,014	14	13·3	19·4	106	72
2	2,000	20	14·2	20·1	141	100
3	1,980	18	15·1	20·8	119	87
4-6	5,841	50	49·2	64·5	102	78
7-11	8,974	80	83·5	106·8	96	75
12-19	11,996	108	113·9	152·0	95	71
29-28	10,346	105	113·0	155·7	93	67
29-34	5,298	71	77·3	107·6	92	66
35-39	3,493	67	70·2	96·1	95	70
40-51	5,322	210	203·3	267·6	96	78
Totals,	57,164	743	753·0	1010·6	99	74

Examining first column 5 of the above table, we see that the ratio of Actual to Expected Deaths is highest in the second year after marriage; that it rapidly diminishes till about the sixth year; and from that time onwards remains practically constant; while the ratio in the first year is shown to be less than that of the next few years, but rather higher than at subsequent periods.

Turning now to column 6, we find that the progression of the ratios there given follows closely that of the previous column. We again notice that the most dangerous period of married life appears to be the second year, and that, after diminishing rapidly for a few years, the ratios remain, as we should expect, practically constant.

The only noticeable difference between the two columns is that the ratio of the first year is here rather lower in comparison with later years than in the previous case, and that the diminution ceases rather sooner.

But for the well-known dangers attending child-birth, we might possibly, with the present arrangement of the facts according to duration, be able to trace to some extent the effect of the selection exercised by marriage. By merely weeding out and leaving amongst the unmarried those who are suffering from acute or exceptionally dangerous diseases, or those who are on their death-bed, marriage must lighten the average mortality of those who contract it; and we might—apart from the risk I have referred to—expect to find this more forcibly brought out in the earlier years of married life. The death-rate would be lowest in the first year; increasing in the next few years until an ultimate rate was attained; the mortality still being, however, less than that of the unmarried class, because the effect of the inclusion of many of the selected lives would continue to the end of the table.

Whether this selection would have any very appreciable effect in making the mortality of the married lighter in the first few years after marriage than at subsequent periods, or not, it is clear from the above table that there is some more powerful influence on the death-rate acting in the opposite direction; and to such an extent that, instead of the increasing ratios we might look for, we find them to be for the first few years considerably above, and afterwards diminishing to, those at later periods of married life. We might at once assign as this important factor the additional risk attending the first confinement; but it is better to first give some information as to the relative frequency with which this takes place in each year after marriage. For this purpose I have extracted the following table from Dr. Duncan's work on *Fecundity, Fertility, and Sterility*, giving the number of wives married at different ages who bear their first child in each year:—

TABLE V.

Year after Marriage.	Number of Wives.							
	Mother's Age at Marriage.							Total.
	15-19	20-24	25-29	30-34	35-39	40-44	45-49	
1	94	325	126	44	15	4	...	608
2	409	1259	533	135	49	3	2	2390
3	83	202	88	45	17	2	...	437
4	25	50	35	12	10	1	...	133
5	8	31	13	8	1	...	...	61
6	13	10	3	3	3	...	...	32
7	5	14	6	1	1	...	...	27
8	5	3	1	3	...	...	...	12
9	1	3	1	...	...	...	...	5
10	2	3	...	...	...	...	...	5
11	...	1	...	...	...	...	...	1
12	...	1	2	...	...	...	...	3
13	2	1	1	...	...	...	...	4
14	1	1	...	...	..	...	...	2
15	...	...	...	...	...	...	...	...
16	1	...	...	...	...	...	...	1
17	...	...	...	...	...	..	...	...
18	...	...	...	...	...	..	...	...
19	...	1	...	...	...	...	...	1
	649	1905	809	251	96	10	2	3722

Some remarks upon this table, which was compiled from the Edinburgh and Glasgow Registers of 1855, will be found in Dr. Sprague's paper, "On the Probability that a Marriage entered into at any age will be Fruitful" (*J.I.A.* xxv. 169).

One can hardly fail to notice the striking resemblance in the general features of the above with those of Table IV. Besides confirming the conclusion that the high ratio of the second year is due to the greatest number of first births occurring then—the average time intervening between marriage and the birth of the first child being about seventeen months—a comparison of the two tables affords, I think, a clear explanation of the decreasing ratios in Table IV. In the fourth year we see a great diminution in the number of wives, who then bear their first child; and a corresponding feature is found in the mortality. Also, when that period after marriage has been reached, when no first births occur, or when the number has become very small, the effect is observable in Table IV., where the ratios have become practically constant.

Although the entrants at the higher ages are comparatively few, the results in Table IV. may, to a certain extent, be affected by including those who are past child-bearing; and it may be as well to exclude the older lives. It might have been useful to tabulate the ratios

of Actual to Expected Deaths for, say, quinquennial groups of ages at observation, but the facts are not numerous enough for this.

The following table shows the ratios, after grouping, for ages 16 to 45 inclusive; and in order to see if similar results are obtained when the ages are within smaller limits, and the period of life examined is that at which most births take place, I have shown also the ratios for present ages 16-30. As there were no marriages before age 16, figures will of course be wanting after 30 years in the first, and after 15 years in the second case.

TABLE VI.

Year after Marriage.	Exposed to Risk.	Deaths.			Ratio of Actual to Expected Deaths.	
		Actual.	Expected according to			
			Table II.	H^F.	3 ÷ 4 × 100	3 ÷ 5 × 100
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Present Ages 16–45.						
1	2,000	14	13·2	19·2	106	73
2	1,983	19	14·1	19·9	135	95
3	1,960	16	14·9	20·5	107	78
4–6	5,744	48	48·3	63·4	99	76
7–10	7,024	59	64·4	83·3	91	70
11–17	9,849	85	90·8	119·3	94	71
18–30	6,552	61	62·1	83·5	98	72
Totals,	35,112	302	307·8	409·1	98	74
Present Ages 16–30.						
1	1,728	13	10·6	15·8	123	82
2	1,664	14	11·0	15·9	127	88
3–6	5,634	43	43·5	59·2	99	73
7–12	3,846	35	34·9	45·0	100	75
13–14	118	1	1·1	1·4	91	71
Totals,	12,990	106	101·1	137·3	105	77

Beyond the fact that the above results in no way alter the conclusions at which we have already arrived from Table IV., I do not think there is anything further to be gathered from them. The higher mortality is perhaps not quite so forcibly brought out, especially in the second part of the table. If this slight difference is really a feature of the mortality, and not merely an irregularity, it might be explained by the fact, that we are now considering that period of life at which most births occur; and, while the risk of the first birth is still very pronounced, the danger attending subsequent confinements is also brought out to some extent, especially in the second part of the table.

In an inquiry of this sort, as explained by Dr. Sprague (*J.I.A.*

xix. 412), the particular groupings of years adopted are intended as a means of roughly graduating the results. Various tentative groupings are made, and that which gives the greatest regularity is adopted. Exception to this mode of procedure has been taken by some, on the ground that important points in the curve may be missed; or that—the process being somewhat arbitrary—the results obtained depend upon the skill of the computer. Whatever merit may attach to a grouping according to fixed intervals, where the facts are numerous, and the results are to be used as a basis for further calculations, it is clear that such a course would be of very little use where there is a paucity of data. The results for combined years would still exhibit considerable irregularities; and we should be no nearer obtaining any idea of the true form of the curve. This applies especially to the present case, where the figures, somewhat limited in the aggregate, are still more scanty, when divided up according to age and duration. We must be content if, by a judicious grouping—according to no fixed intervals and seemingly erratic—we can get rid of the irregularities; and ascertain in this way the principal feature of the table. Some of the groups adopted must necessarily include a good many years, but the advantage of taking smaller groups, and thereby making apparent minor points, would be annulled by the loss in regularity. There would be nothing to guide us as to whether these points were really features of the table, or merely irregularities.

Having considered the changes to which the mortality of married females of the same age is subject, according to the time elapsed since marriage, the following death-rates for a group of ages at entry, show the combined effects of the duration of married life and increased age. The Exposed to Risk and Deaths for ages 18-31 at marriage are shown in columns 2 and 3 of the following table; and, in column 4, the rates of mortality obtained after grouping :—

TABLE VII.

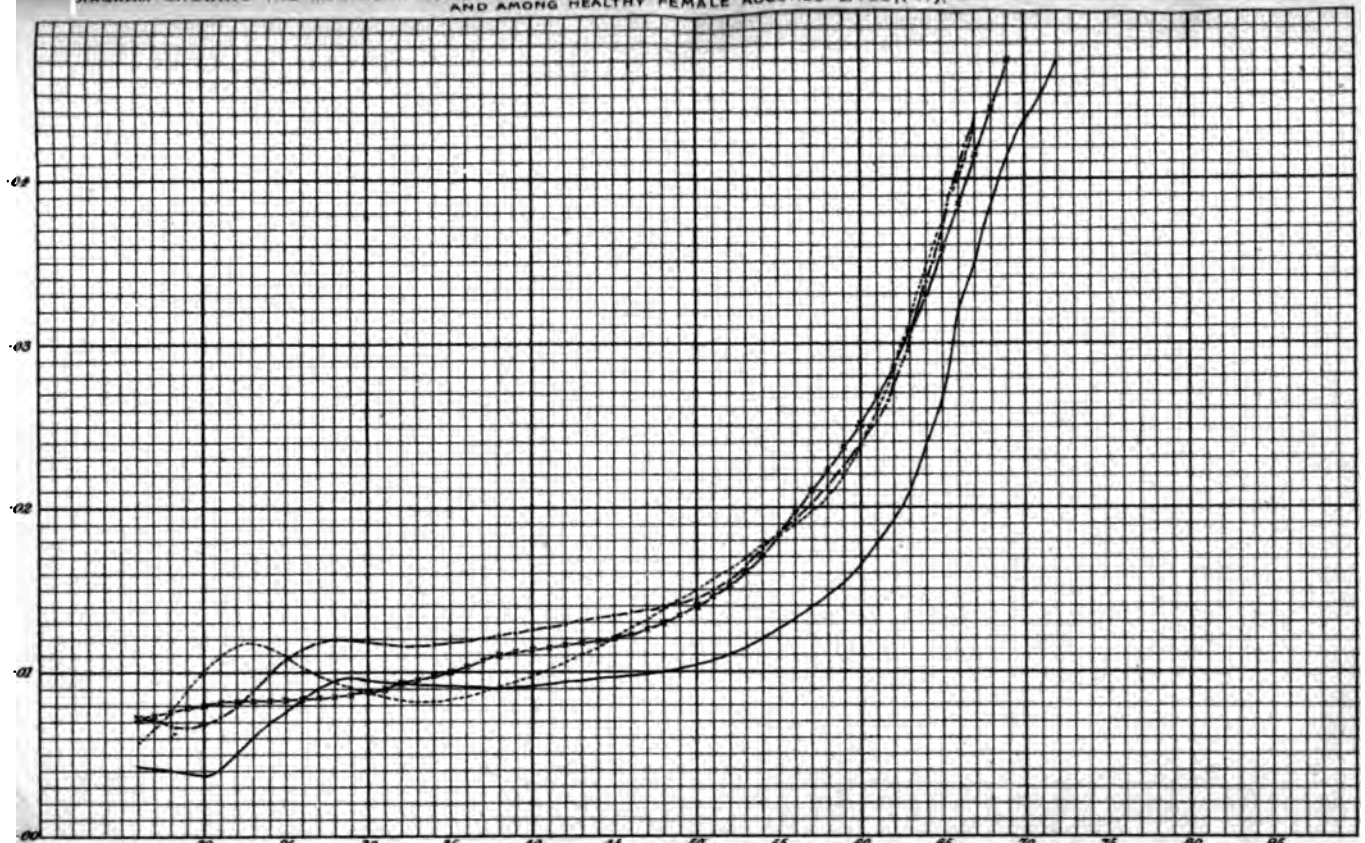
Year after Marriage.	Exposed to Risk.	Deaths.	Rate of Mortality.
(1)	(2)	(3)	(4)
1	1,750	11	·0063
2	1,737	16	·0092
3–6	6,810	55	·0081
7–10	6,354	53	·0085
11–14	5,653	51	·0090
15–19	6,238	58	·0093
20–24	5,334	54	·0101
25–30	5,366	60	·0112
Totals,	39,242	358	·0091

From these figures alone we might almost be led to suppose that the higher mortality at the commencement of the table is due to chance, and to assume the rates to be, if ascertained for individual years, practically constant. I must admit that I thought that the above table would have exhibited rather more clearly the features previously brought out. The only reason I can assign for this not being the case, is that allowance must be made for the usual increase we must expect as the lives get older. We find evidence of such increase after a few years; and we learned from the previous results that the mortality has at first a tendency to diminish. It is, therefore, impracticable, unless the facts are considerably more numerous than in the present case, to ascertain exactly where the diminution ends and the increase begins; but I think the grouping I have adopted gives some indication of this.

In conclusion, the following remarks are suggested by an inspection of Table III. and the diagram illustrating it. Female assured lives constitute a special class of their own; and from a comparison of the present rates with those of the Peerage Males we are not able to draw any conclusions as to the additional risk of married female over male assured lives. In the Peerage class the two sexes do not show the same difference as among assured lives. Apart from this, it may be of interest to notice the similarity between columns 4 and 5. While the mortality of the married females is considerably lower than the H^F, the formation of the two curves is seen to be very much the same. This might be expected, as it is generally found that the greater proportion of insurances on female lives are effected on the lives of married women. A comparatively rapid rise from ages 20 to 25 is followed by a mortality nearly constant from 25 to 50. This latter feature is of course one that is found in most experiences of female lives, but it is rather more marked in these two tables. The figures I have brought out satisfactorily explain it. The fresh marriages at each age produce, as shown above, a tendency in the death-rate to diminish; and when we are dealing with a table irrespective of the duration of married life, the mortality does not increase with age to the extent it would otherwise do.

These results show, I think, that an insurance on the life of a married woman should be considered with regard to the time for which she has been married; that those offices, which charge a single extra when marriage has been recently contracted, are justified in their practice; and that it would seem to be advisable, in the case of unmarried women, to allow for an extra premium on marriage.

DIAGRAM SHOWING THE MORTALITY AMONG THE MARRIED FEMALES, FEMALES GENERALLY, AND MALES OF THE PEERAGE CLASS, AND AMONG HEALTHY FEMALE ASSURED LIVES, (H^F).



MARRIED FEMALES ———; PEERAGE FEMALES —·—·—·—; PEERAGE MALES - - - - - - - - - - - -; H^F — — — — —;.

INDEX.

A Description of certain of the Principal Stock Exchange Securities.

BY

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A Description of certain of the Principal Stock Exchange Securities.

MANY valuable papers have from time to time appeared among our own Transactions and in the *Journal of the Institute of Actuaries* bearing upon the *Amounts invested* by Life Offices in various securities, and the rates of interest yielded by such investments at different epochs. So far as I can discover, however, with the exception of a short, but very instructive, paper on Railway Debenture Stock by Mr. Coles in the 15th vol. of the *Journal*, nothing has been written in description of the origin and character of the various securities which are usually selected for the investment of Life Offices' and other Funds. Having discovered that many others besides myself have experienced difficulty in obtaining information on this subject, I have ventured to put down in an elementary way the results of my own research in regard to it.

The President of the Institute of Actuaries, in his Inaugural Address, delivered recently, impressed upon his hearers the imperative necessity for the Actuary being now a *practical financier* also, and I am sure that every one of us knows sufficient about the difficulties that beset the investment of money at the present day to fully indorse his remarks. No one can, however, it seems to me, be a "practical financier" without having an intelligent knowledge of the character of various securities, and it is my desire to-night to try to help in some small measure towards the attainment of that knowledge.

Intimate acquaintance with the outs and ins of the various classes of Stock Exchange securities is no doubt obtained only after considerable experience in dealing with them, and I must content myself therefore at this time with giving such information as I can regarding them, in the hope that it may be of assistance to those at least who are on the threshold, as it were, of the subject.

Classification of Securities.

The Securities usually dealt in by Investors may no doubt be classified in many different ways. We may, however, for our purpose, arrange them into three groups, namely, (1) Those usually termed the "Gilt-edged" or Trustee Securities; (2) Those which are not usually included in the first class, but which, all the same, may form very desirable

investments for the funds of a Life Office; and (3) Those which are of too speculative a character to be classed in either of our other two groups, and which are therefore unsuitable for the investment of Life Offices' Funds. We shall deal chiefly or almost altogether with the securities included in the first two groups.

The Rate of Interest an Index to character of Investment.

The rate of interest yielded by an investment is usually a very good index to the class of security in which it should be included, according to the well-known rule that a very high rate of interest signifies a weak security. In fact, any return over and above the market rate is generally to be regarded as of the nature of a risk premium rather than as interest.

The Trustee Acts. Investments.

The List of Investments allowed by the Trustee Acts will show us very clearly which securities are to be included in our first group. The List for England differs in many respects from that for Scotland, and this may perhaps occasion confusion in regard to the investments of some estates. The following statement will show (1) which classes of securities in their entirety are allowed by *both* Acts; (2) Securities allowed by both which are of the same genus but of different species, so to speak; and (3) Securities which are allowed by one or other exclusively.

I. SECURITIES ALLOWED BY BOTH THE ENGLISH AND SCOTCH ACTS.

(*a*) Government Stocks or Public Funds or Securities of the United Kingdom.

(*b*) Stock of the Bank of England.

(*c*) Securities the interest of which is guaranteed by Parliament.

(*d*) India 3 and 3½ per cent. Stocks.

II. SECURITIES ALLOWED BY BOTH UNDER VARYING CONDITIONS.

(*a*) Debenture Stocks of Railways in United Kingdom:—

England.—Where not less than 3 per cent. has been paid on Ordinary Stock for past ten years.

Scotland.—Without any such qualification.

(*b*) Railway Rent Charge, Guaranteed and Preference Stocks:—

England.—With same qualification as in the case of Debenture Stocks.

Scotland.—Where dividends are "cumulative" and *a* dividend has been paid for the past ten years on the Ordinary Stock.

(*c*) Stock of a Railway leased to another Company:—

England.—If the lease is for not less than 200 years at a fixed rent.

Scotland.—If there is a lien retained over the undertaking.

(*d*) Stocks of Municipal Corporations issued under Act of Parliament:—

England.—Of towns of over 50,000 inhabitants.

Scotland.—Without such restriction.

(*e*) Debenture Stock of Indian Railways, interest of which is guaranteed by Government:—

Scotland only allows *Loans* on this class of Stock.

III. SECURITIES WHICH ARE ALLOWED BY ONE OR OTHER EXCLUSIVELY.

England.—Bank of Ireland Stock.

Indian "B" Annuities and "D" and "C" Annuities of the East Indian Railway.

Debenture and Preference Stock of any incorporated Water Company in Great Britain which has paid for past ten years a dividend of not less than 5 per cent. on its Ordinary Stock.

Water Trust Stocks of towns of over 50,000 inhabitants, where assessment for past ten years has not exceeded 80 per cent. of the amount authorised.

Scotland.—Colonial Bonds, not payable to bearer, approved by Court of Session.

The English Act permits the purchase at a premium of redeemable stocks, but prohibits those stocks which are liable to redemption at par or other fixed rate within fifteen years of the date of purchase, or which stand at a premium of 15 per cent. above the redemption value.

Principles to be observed in investing Funds.

In the 10th vol. of the *Journal of the Institute of Actuaries* Mr. Bailey states what he considers are the principles to be observed in investing the funds of a Life Office, and these may help us in selecting securities which are not in our first group and which may be suitable for inclusion in our second group. The rules given by Mr. Bailey are as follows:—

1. That the first consideration should invariably be the security of the capital.
2. That the highest practicable rate of interest be obtained, but that this principle should always be subordinate to the previous one, the security of the capital.
3. That a small portion of the total funds (the amount varying according to the circumstances of each individual case) should be held in readily convertible securities for the payment of current claims, and for such loan transactions as may be considered desirable.
4. That the remaining, and much larger, proportion may safely be invested in securities that are not readily

convertible, and that it is desirable, according to the second principle, that it should be so invested, because such securities, being unsuited for private individuals and trustees, command a higher rate of interest in consequence.

5. That as far as practicable the capital should be employed to aid the Life Assurance business.

Stock Exchange terms.

Before proceeding to examine in detail the securities most frequently dealt in by investors, we may consider shortly some of the *terms* most frequently made use of in financial circles.

Stock, Shares, Bonds.

Governments and Corporations issue their loans in one or other of three forms, namely, *Stock*, *Shares*, or *Bonds*.

Stock and Shares would seem to imply more personal interest than Bonds do in the *purpose* for which a loan is raised.

Stock was no doubt originally the name given to the capital of the loan by the borrower. It is that whereon he is to trade or to carry through the purposes he has in view.

Shares may, on the other hand, be said to be the same capital from the lender's point of view. They express his interest in the success of the venture for which the capital is raised.

Bonds are usually taken up by those who simply desire an investment, with security for the safe return of their capital, without much consideration as to whether or not the borrower is very successful in the enterprise for which he asks the loan.

Consequently the return on the capital of Stock and Shares usually varies with the variation in the success of the undertaking; while the interest on Bonds is always a fixed quantity. Further, in the case of Stock and Shares the borrower usually does not agree to repay the capital at any time, and hence the value of the lender's capital at certain dates will depend on what may be realised for it then in the market, and will vary with the variation in the return as well as for other reasons. Under a Bond, on the other hand, the lender binds himself to return a certain sum at an agreed-upon date.

Stock and Bonds are usually nominally for fixed hundreds of pounds, and do not carry liability for the contribution of any further amount than that already subscribed.

Shares may be for any sum, and may be fully or only partially subscribed.

"Shares are not necessarily converted into Stock as soon as they are paid up; they may exist either as paid-up shares or as not paid-up shares. But as regards Stock, that can only exist in the paid-up state. In popular language, however, a stockholder in a railway is known as a shareholder, and in law he possesses so much of the same essential character that a bequest by a testator who was both

a share and stock holder 'of all his railway shares' was held to pass the Stock."

As we have already said, Stocks and Bonds are usually for even hundreds of pounds, but they may be issued, or be selling in the market afterwards, either at a discount, or at a premium, or at *par*. If the credit of the borrower is low, he may, instead of offering a larger rate of interest, agree to accept less than the nominal value of the loan, though he binds himself to pay interest on the nominal amount and to repay the loan at maturity in full. On the other hand, if the credit of the borrower is very good, he may, instead of *reducing* the interest, require a premium on the issue price of the loan. If Stocks or Bonds are issued, or are selling in the market, at their nominal value, they are said to be at *par*.

Shares at a Premium, at a Discount, or at Par.

The final title of an investor to an interest in any public fund or loan is called a Stock or Share Certificate.

Stock Certificate.

Inscribed Certificates are those having the *name* of the holder inserted in them, as opposed to those payable to *Bearer*.

"Inscribed" Certificates.

Scrip, said by some to be an abbreviation of the word subscription (but more probably derived from *scriptum*) is applied to the document certifying payments of deposit and calls prior to the issue of the final certificate, and is dealt with in that form. The shares of all new companies are generally issued as Scrip immediately after the first deposit has been made, and are not registered till some of the calls have been demanded. Many foreign railway shares, etc., continue to be dealt in as Scrip even after the shares have been fully paid up.

"Scrip."

Dividends are the half-yearly payments of interest on different Stocks and Shares; and are, as the word implies, the shares in the division of profits accruing from Joint-Stock Companies in general. The dividends are usually remitted to the proprietors by orders on the Company's bankers, and these orders are called Dividend Warrants.

"Dividends."

Dividend Warrants.

Coupons (derived from the French "Couper") are Dividend Warrants annexed to Bonds for certain classes of loans, generally of Foreign and Colonial Governments, for the purpose of being *cut off* by the holders themselves and presented for payment as they fall due.

"Coupons."

Ex-Dividend is a term used to show that the buyer of Shares or Stock or Bonds is not entitled to the Dividend then payable or about to fall due.

"Ex-Dividend."

Cum-Dividend, on the other hand, means that the buyer is to receive such Dividend.

"Cum-Dividend."

There are many other terms in addition to the above used on the Stock Exchange, such as *Bull*, *Bear*, *Contango*, *Backwardation*,

Time Bargains, etc., but they apply chiefly to pure speculations—virtual gambling—on the rise and fall of Stocks, and we need not notice them here.

We may, however, refer here to a term or qualification that is frequently applied to many Stock Exchange Securities, namely the word *consolidated*. We have "Consolidated Ordinary Stock," "Consolidated Preference Stocks," "Consolidated Debenture Stocks," and so on, and it may be well to explain the term somewhat fully. It will be found from any of our Dictionaries that to *consolidate* means to unite several smaller pieces into one solid mass. Hence a debtor who owes twenty people £100 each on some security may get some one creditor to advance him sufficient to pay off all the others, and thereafter he will have only one creditor for the debt of £2000 in place of twenty as formerly. In this way he *consolidates* his debt. Similarly a Railway Company or other Corporation may consolidate loans of various amounts, raised at different dates, under different conditions, and at different rates of interest, into one loan bearing one uniform rate of interest, and subject generally to the same regulations and conditions. There are evident advantages to be derived both by the borrower and also by the lender from consolidation. As regards the borrower—say a Railway Company—it is much easier and also less expensive to manage one Stock for £1,000,000, than to manage ten separate Stocks of £100,000, each requiring separate bookkeeping, and having perhaps dividends payable at different dates. The advantage of consolidation to the lender will no doubt lie chiefly in the improvement of his investment—a large well-known Stock being much more likely to realise a readier market and a higher price than one of smaller amount which is infrequently dealt in, and is therefore very little known to investors.

"Consolidated."

Advantages of Consolidation.

Another term that is frequently added to various Stock Exchange Securities is the word "Perpetual." We have "Perpetual Preference Stock," "Perpetual Debenture Stock," etc. The term simply means that such stocks are irredeemable.

"Perpetual" Stocks.

It may not be out of place to point out here that the quotation in many Stock Lists of the yield of redeemable securities which are selling at a premium is often misleading, owing to the fact that no allowance is made for the securities being payable only at *par* on redemption.

With a view to discovering which classes of Securities are at present most open to, or most in favour for, the investment of Life Offices' Funds, I annex a Table, taken from the Board of Trade Returns, showing how the amount invested by all the Ordinary Life Assurance Offices of the United Kingdom during last year

was placed. It will be seen from this that Mortgages decreased £372,520 in amount, and Loans on Personal Security were less by £66,724 than in the previous year. The Surplus Income invested was £7,926,564, and, adding the repayments from the two heads referred to, the total of these amounts for which investment was actually found during last year was no less a sum than £8,365,808. Our Table shows that as much as 24 per cent. of that amount was invested in Debentures, 22 per cent. in Stocks and Shares, 15 per cent. in Indian and Colonial Government Securities, and 13 per cent. in Loans on Rates (probably of Colonial Townships chiefly); or, under these *four* heads together three-fourths of the whole amount invested was placed. If we assume that "Life Interests and Reversions" are largely composed of Consols, we have an increase in the year of about £700,000 on British Government Securities, making the total amount still held under that head, directly or indirectly, by British Offices, close upon £10,000,000.

INVESTMENTS OF ORDINARY BRITISH LIFE OFFICES.

Securities. (1)	Year 1894. (2)	Year 1895. (3)	Difference. (4)	Percentage of (4) of £8,365,808.
	£	£	£	
Mortgages	84,743,199	84,370,679	- 372,520	...
Loans on Policies	10,270,509	10,615,387	+ 344,878	4·2
Loans on Rates	21,420,034	22,527,487	+ 1,107,453	13·2
British Government Securities	4,868,072	4,922,976	+ 54,904	·5
Indian and Colonial Securities	15,654,471	16,886,608	+ 1,232,137	14·7
Foreign Securities	4,162,339	4,602,789	+ 440,450	5·3
Debentures	27,012,987	29,010,542	+ 1,997,555	24·
Shares and Stocks	14,415,667	16,226,370	+ 1,810,703	21·6
Companies' Own Shares	606,415	620,709	+ 14,294	·2
Land and House Property, and Ground Rents	14,781,487	15,490,108	+ 708,621	8·5
Life Interests and Reversions	4,150,874	4,805,687	+ 654,813	7·8
Loans on Personal Security	1,551,254	1,484,530	- 66,724	...
	£203,637,308	211,563,872	+ 8,365,808	
		203,637,308	- 439,244	
		£7,926,564	£7,926,564	

We shall now describe some of the principal Stock Exchange Securities in detail. And first of all we have

British Government Securities.

In the front rank of the "Gilt-edged" Securities, and in fact in the very front of all securities, must, without doubt, be placed the British Government Stocks. In examining and describing these it will be necessary to trace to some extent the origin and history of the National Debt, and we shall endeavour to do this as shortly as possible. There seems the more reason for doing so here from the fact that there is really some difficulty in getting clear information regarding many points connected with the National Debt which should be of the greatest interest and importance to every British subject.

The National Debt.

In earlier times loans were made, not to the nation, but to the Sovereign. Henry VII. borrowed from the City of London £4000, which sum he punctually repaid, and Queen Elizabeth's exactness in repaying loans made to her has also been noticed. William III. was the first who borrowed money for which the credit of the nation was pledged; and in 1694, for the first time in our history, the item Interest and Management of the Public Debt appears in the National Accounts.

"Unfunded" Debt.

In its earlier history the National Debt was "Unfunded" in character—that is to say, it consisted simply of loans which the Government had borrowed for various periods, and which it was bound to pay off at certain fixed dates.

"Funded" Debt.

As its indebtedness increased, however, the Government, in order to avoid the inconvenience and anxiety of having to provide, by borrowing anew, for repayment of large sums falling due perhaps when the market was in an unfavourable condition for raising money, resorted to the expedient of "funding" the Debt, a practice which appears to have originated with the Italian Republics. By "funding" is meant simply that the Government undertook to pay interest on its indebtedness annually, or semi-annually, at an agreed-upon rate, but reserved to itself the power of repaying the principal only at such time as it might choose. The word "Fund" originally implied the special taxes or "funds" set apart for meeting the charge on the money borrowed, not, as now, the principal of that money itself.

"Consolidated Fund."

The term still survives in the expression "Consolidated Fund," which is the name given to that part of the National Revenue which is set apart to meet chiefly the charges for interest, etc., on the National Debt.

The National Expenditure falls under three Categories—

(1) The Consolidated Fund Charges (for year to 31st March 1895) . . .	£26,642,421
(2) Army and Navy	35,445,000
(3) Civil and Miscellaneous Services, including Expense of Collection of the Revenue	31,831,000

The Consolidated Fund Services are as follows—		
For Interest on National Debt, Annuities, Sinking Fund, Management of the Debt, and all other charges connected with the Debt		£25,000,000
The other Charges on Consolidated Fund were as follows:—		
Civil List	£407,774	
Annuities and Pensions .	316,758	
Salaries, etc. . . .	81,618	
Courts of Justice . .	514,633	
Annuities and Miscellaneous	321,638	
		1,642,421
Total Consolidated Fund Charges		£26,642,421

Consequent upon the "funding" of various loans came the consolidation of the national indebtedness. As we have already noticed, consolidation makes the management of debt much easier and also less expensive. It may be interesting to state that the first, or among the first, consolidation of the Government Debts was undertaken by what would nowadays be called a Syndicate. Owing to Marlborough's wars the public credit had sunk to a low ebb. Floating obligations to the amount of many millions were selling in the market at a discount of 40 per cent. To the amount of over nine millions of pounds, they were bought up by the famous South Sea Company, which got them converted into Perpetual Stock, bearing 6 per cent. interest. In addition, the Company obtained a charter, giving it a monopoly to trade in Western Seas, though it never did any trading. In 1714 the Government owed the South Sea Company £10,000,000, on which it received 6 per cent. interest, and £8000 for management. Two years later interest was reduced to 5 per cent. Various other financial operations were undertaken by the Company on behalf of the Government, until the total indebtedness of the Government to the Company amounted to over £37,000,000. Interest on the whole of this debt was ultimately reduced to 4 per cent. For the privilege of carrying out these financial operations, the Company offered Government a bonus of £7,000,000, but the money was never paid, as the "bubble" soon burst. The South Sea Stock and Annuities were afterwards all either paid off or converted into other securities.

Consolidation of Debt.

In 1751 several descriptions of English Debt, amounting in all to over £9,000,000, were consolidated into one fund bearing a uniform interest of 3 per cent., an operation which gave origin to the now familiar term "*Consols*" (*i.e.* Consolidated Stocks). Various other stocks, to the amount of

"Consols."

nearly £18,000,000, were consolidated at the same time, forming the commencement of the 3 per cent. reduced Annuities. These Stocks were largely added to from time to time, until they amounted to hundreds of millions.

For our purpose, it is unnecessary to follow the various changes in and consolidations of the Debt, and reduction of interest thereon, which have been given effect to at different periods. We shall rather deal with the Debt as it at present stands. It may be interesting, however, merely to glance at the amount of the Debt at various points, and at the causes which led to its enormous increase at certain times.

Amount of the National Debt at different dates.

In 1688 the whole National Debt amounted to the very trifling sum of £660,000, principally in the form of terminable annuities. During the reign of William III. £15,000,000, and during Queen Anne's reign £38,000,000, respectively, were added to it, making the Debt at the accession of George I. in 1714, £54,000,000. Further large increases were made at various times, while only unimportant decreases were effected, so that at the commencement of the American War in 1775 the Debt stood at £128,000,000. At the end of the American War it was just about doubled, its amount then being £250,000,000. The French War added the enormous sum of over £600,000,000 to the Debt, so that January 1816 has the unenviable distinction of being the date at which, during its whole history, the Debt has stood at its highest point. Reckoned according to the present method of capitalising annuities, the Debt stood at that date at a little over £900,000,000. Contemplating the possibility of the National Debt increasing to £200,000,000, Dr. Price exclaimed, "*One cannot reflect on this without terror!*" What would have been the good Doctor's feelings if it could have been made known to him that it would by and by rise to £900,000,000? Since 1817 considerable reductions have in one way or another been made in the amount of the funded Debt, so that at 31st March 1895 it stood at £660,000,000 (still further reduced at 31st March 1896 to £652,500,000).

The National Debt at its highest amount.

It may safely be said that the National Debt should never have reached the enormous figure it did, if it had not been for the insane ways in which most of the loans composing it were raised. The credit of the Government was, no doubt, very much down when they borrowed, and, instead of paying a larger rate of interest and borrowing at *par*, they paid 3 per cent. only, and issued the loan at an enormous discount. For example, in 1793 a 3 per cent. loan of 4½ millions was offered at a price of £72 per cent., the Government thus making itself liable for £6,250,000. Between 1776 and 1785 for £91,763,842 actually borrowed by Government, £115,268,000 was undertaken to be repaid, besides

bonuses in the form of Terminable Annuities to the value of £10,000,000. No wonder the country's indebtedness increased! Had the Government borrowed at *par* and paid interest at the rate of say 6 per cent., instead of only 3 per cent., the annual charge for interest would have been higher for a time, but the Debt itself would have been less in amount by several hundred millions than it is, and it would have been a very easy matter to reduce the rate of interest as the credit of the Government improved.

National Debt at 31st March 1895.

We will now refer to the component parts of the National Debt as it stood at 31st March 1895, and also notice the methods that have been, and are being, employed to lessen its amount.

The National Debt then is of three descriptions, viz.:—

I. *The Funded Debt*, made up of the following—

(*a*) £522,000,000 Consols (Goschens), interest 2¾ till 1903, and thereafter 2½ per cent.
(*b*) 4,650,000 2¾ Consols.
(*c*) 32,000,000 2½ „
(*d*) 11,000,000 borrowed from the Bank of England at various times.
(*e*) 2,600,000 borrowed from the Bank of Ireland at various times.

The reason that there are *three* different descriptions of Consols is that in 1884 Mr. Childers, as Chancellor of the Exchequer, gave the holders of 3 per cent. consols the *option* to convert each £100 of their 3 per cent. Stock either into £102 2¾ consols or into £108 2½ consols. In both cases the Stocks are not redeemable until after 5th January 1905. The 2½ per cents. were originally created by Mr. Gladstone in 1853. In 1888 and 1889 Mr. Goschen compulsorily effected the conversion of the remainder of the old 3 per cent. Stock into consols bearing 2¾ till 1903 and 2½ thereafter. This Stock cannot be redeemed till 1923, and thereafter at *par*.

II. *Terminable Annuities*, consisting of—in capital value—

(*a*) £11,650,000 Life Annuities.
(*b*) 43,000,000 Savings Bank, Chancery Fund, and other Annuities.

III. *The Unfunded Debt*, consisting of loans borrowed for short periods, and represented by Exchequer Bills, Exchequer Bonds, and Treasury Bills, amounting to between £17,000,000 and £18,000,000. There were also Book

Debts to National Debt Commissioners amounting to £13,000,000.

The Government are also primarily responsible for (1) £41,000,000 Local Loans 3 per cent. Stock which was created to provide advances to commissioners and other local authorities who borrow from Government; and (2) for £1,700,000 guaranteed 2¾ per cent. Land Stock (Ireland).

As a set-off to their liabilities it should be stated that the Government have assets valued at about £25,000,000. They consist of the Suez Canal Shares, estimated at £24,000,000, and certain annual payments from the Colonies (for instance £35,000 per annum by the Australian Colonies under the Imperial Defence Act 1888), valued at another £1,000,000 in all.

Income from taxation is only collected gradually, and cannot therefore supply a fund for meeting the immediate expense of the Public Service. To provide for such expense until the taxes of the year are gathered in, the Government are empowered to issue Exchequer and Treasury Bills, and Treasury Bonds.

Exchequer Bills. Treasury Bills. Treasury Bonds.

Exchequer Bills were first introduced to supply the want of a circulating medium owing to the scarcity of metallic money during the great re-coinage of 1695. They were issued at first for sums as low as £5, and carried 7½ per cent. interest. They are now issued for sums of from £100 to £1000; as a rule for short periods only; and they bear a very small rate of interest. They are chiefly serviceable as investments for capitalists who are reserving their funds for some special purpose.

Exchequer Bonds were introduced by Mr. Gladstone in the year 1853 in connection with the redemption of the annuity payable to the South Sea Company and for commuting some of the Public Stocks. They are governed in many particulars by the same rules as are applicable to Exchequer Bills. So long as the blank for the name is not filled up, Exchequer and Treasury Bills and Exchequer Bonds are all payable to bearer.

At various dates in the history of the National Debt, efforts have been made to reduce its amount. At the time of issue of many of the earlier additions to the Debt, a Sinking Fund of 1 per cent. was provided, so as gradually to extinguish the amount of the loan. In some instances it was stipulated that the Sinking Fund should be invested apart from the Debt and be allowed to accumulate at interest so as to discharge the Debt in one sum. This, however, led very often to the Sinking Fund being appropriated by the Government when in need of money, and their so doing raised loud and bitter protests from many quarters. New loans were, however, always raised at considerable expense, and it seems unreasonable to have required the Government to incur such expense in borrowing anew when they

Sinking Funds.

had a fund at hand which they could make use of. True, such appropriation hindered the paying off of the debts the Sinking Fund was provided to extinguish, but it also prevented the contracting of fresh debts, and the expense connected therewith, so that the indebtedness of the country was less in the end by this method than by the other. A Sinking Fund for the reduction of the funded Debt was established in the reign of George I., but after a time it became obsolete. In the year 1786, however, a "New Sinking Fund" was established, and certain Commissioners (the Speaker of the House of Commons, the Chancellor of the Exchequer, Master of the Rolls, Accountant-General of Court of Chancery, and the Governor and Deputy Governor of the Bank of England) were appointed to carry its object into effect. This Sinking Fund originally consisted of £1,000,000 annually, but, after various modifications, it was enacted that it should not be for any fixed amount, but should be derived merely from the surplus revenue of each year. The fund continued in force in this shape till 1875, when another "New Sinking Fund" was established by which ultimately almost £29,000,000 was set aside for the annual service of the Debt. By the Sinking Fund Act 1875 the annual payment was fixed at £28,000,000; by the National Debt Act 1887 it was reduced to £26,000,000; and by the National Debt Act 1889 it was still further reduced to £25,000,000, at which sum it now stands. Out of this fixed annual charge are paid the interest and all charges for management of the Debt, and any balance remaining thereafter is applied to the purchase and cancelment of Stock. The Sinking Fund regulations of 1786 also still hold good as regards any balance of National Revenue being applied in reduction of the Debt. The Commissioners also get handed over to them several miscellaneous Receipts (from Land Tax, Composition of Stamp Duty, Local Loans Restitution Fund, etc.), which last year amounted in all to £300,000. Terminable Annuities it will be seen are also to a great extent Sinking Funds,—each payment of annuity being composed partly of interest and partly of repayment of capital. In 1866 Mr. Gladstone cancelled Stock bought with £24,000,000 Savings Bank Deposits, and turned it into Terminable Annuities ending in 1885. The annual charge was by that means increased to £1,725,000 from £720,000, the difference of £1,005,000 being in reality a Sinking Fund. Mr. Gladstone believed that the nation was much more likely to pay off its Debt more speedily in this way than by a direct Sinking Fund charge.

Besides its own Debt, the British Government has, for various causes, made itself responsible for either the principal, or the interest, or for both principal and interest, of Loans to India, some of the Colonies, and even some foreign countries. For instance, "The Canada Guaranteed 4 per cent. Bonds" were issued in con-

nection with a loan for the construction of a railway between Quebec and Halifax, and the interest of the loan is guaranteed by the British Government. Again, "The Turkish Guaranteed Loan" was raised during the Crimean War to give Turkey the means of carrying on hostilities against Russia, and the interest of it is guaranteed jointly by France and Britain.

Regulations as to Transfer, etc., of British Stock.

Stock is transferable by attendance of the seller or transferor, either personally or by his attorney, at the Bank of England to sign the transfer form made out in the Bank books.

Stock Certificates to Bearer can be obtained in amounts of £100, £200, £500, and £1000, at a fee of 2s. per cent.

The proprietor or his attorney must attend at the Bank to sign the books and transfer Stock into Certificates to Bearer. Such certificates may be re-inscribed on payment of 1s. per certificate.

Holders of English Stocks can insert a name, and so make the certificate "nominal," in which case it cannot be re-inscribed in any name other than that so inserted.

"Nominal" Certificates, if duly indorsed, may be exchanged for Bearer Certificates on payment of 1s. per certificate.

Indian and Colonial Government Securities.

It will not be necessary to enter fully into details of these Securities, seeing that we have already dealt at length with the British Government Stocks. We may, however, notice very shortly one or two points regarding them.

The Indian Government Debt is of two classes: (1) The Sterling Debt, amounting to over £100,000,000, and (2) The Rupee Debt (known as "Rupee Paper"), for about a similar amount. The former has been raised in this country; the latter has been raised in India. More than half of the total Indian Debt has been incurred in constructing railways, and £30,000,000 of it has been expended in irrigation works. The greater part of the Debt is thus productive in character. The Sterling Debt is held in much the same way and under conditions very similar to those under which the British Government Stocks are held. The Rupee Stock can be held in Britain either in the form of Promissory Notes or as Registered Stock. The Promissory Notes are known as "Enfaced Paper," when a notification is printed on the face of them that "interest is payable in London by draft on Calcutta." The fluctuating character of, and the tendency to further serious fall in the value of, the Rupee, taken with the inconvenience of having the interest payable by draft on Calcutta, renders Rupee Paper an undesirable security for

"Rupee Paper."

"Enfaced Paper."

an investment. The Indian Debt—other than the Rupee Paper and India Debentures—comes within the Trust Acts. It is, however, open to question whether it is really entitled to the distinction of being included among the Trustee Securities, seeing that it is not directly guaranteed by the Home Government.

Colonial Government Loans.

The Colonial Government Loans have been raised in some instances under authority of the Imperial Parliament, and in others by Acts of their own Legislatures. They have been contracted in most cases for productive works, such as railways, and the actual strain of debt is therefore not so heavy in their case as it might appear at first sight. The loans are nearly all redeemable at fixed dates, and many of them are being gradually paid off by Sinking Funds of fixed annual amounts. Bonds and Debentures are also in many cases being redeemed by annual drawings. Thus far there has been no instance of default among any of the Colonial Governments, and accordingly their credit is generally high. Many of the Australian Colonies have, however, until within comparatively recent years, taken rather full advantage of the facility for borrowing which this high credit has given them, and as a result they are only now emerging from a recent severe crisis.

As regards transfer, most of the Colonial Government Securities follow the plan adopted by the Bank of England with regard to transfer of British Government Stock. A few, however, follow the plan originally inaugurated by Canada, of transfer by means of deed instead of in the Books of the Stock.

The following points, among others, have been suggested as worthy of consideration in connection with Colonial Government Loans:—

1. The favour with which the Public Debt of a colony is regarded should be contingent on the amount of debt expended on public works and the relative reproductiveness of such expenditure.

2. Although the mode of reckoning debt at so much per head of population is to a certain extent fallacious, it is yet a very important factor in the matter.

3. Existence of large tracts of unalienated lands in a colony is a source of strength, as representing latent capital.

4. It is desirable that a larger portion of Colonial Debts should be raised in the Colonies themselves, as large annual payments for interest to be remitted to this country must eventually be the source of considerable difficulty.

Municipal Stocks.

Originally Corporations raised what money they required on Mortgage, but this method was found very inconvenient and expen-

In the above total capital of £985,387,355 is, however, included a sum of £81,044,811 (or over 8 per cent. of the whole) of merely nominal capital due to the Conversion and Consolidation of Stocks. For instance, the London and North-Western Railway Company converted their 4 per cent. Debenture Stock into new 3 per cent. Stock, on the basis of equal income, viz., £133, 6s. 8d. of new Stock for every £100 of the old. The nominal addition to the capital on conversion was in this case upwards of nine millions; but of course the dividend payable on the increased capital was the same in amount as had been formerly payable on the old Stock. Such nominal increases of capital are known as "Watering" of Stocks. The term is most commonly applied to the splitting up of the *Ordinary* Stocks into Preferred Ordinary and Deferred Ordinary, as explained hereafter.

"Watering" of Stocks.

There is no liability attaching to fully paid-up Shares or Stocks of Railway or other Companies incorporated by Act of Parliament. The chief drawback, however, to investment in the Ordinary Stocks of Railway Companies is the great liability to fluctuation in the dividends from year to year. As the dividends applicable to the Guaranteed, Preference, and Debenture Stocks have to be met before any dividend is payable on the Ordinary Stock, it is apparent that if from any cause, such as the extensive coal strike of 1893, the earnings of the Company for any year are sensibly diminished, the result must affect in the first place, and perhaps alone, the Ordinary Stockholders.

In terms of the Companies Clauses Act 1863, when a Railway or other Company is authorised by Special Act to raise additional capital, it may do so by the creation either of new Ordinary Shares or Stocks, or new Preference Shares or Stock; in either case, if the existing Ordinary Shares be at a premium, the first offer of the new Shares or Stock must be made to the existing shareholders, unless the Company determines otherwise before the issue of the new Shares or Stock.

Creation of Additional Capital.

Increases of capital have of late years been required a good deal for the purpose of providing, on account of competition, increased facilities and improved means of conveyance to the travelling public. Such increases have not borne proportionate increases in earnings, and consequently the surplus of Revenue available to meet the dividends on the Ordinary Stock has in most cases been lessened thereby. This is a further objection to investment in "Ordinary" Railway Stocks.

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twelve thousand millions sterling, and we see that the Railway Capital is exactly one-twelfth of that total.

In America, it may be mentioned that expenditure for the purpose of improvement, etc., of existing lines is called "Betterments," and is usually charged to *revenue* and not to capital.

"Betterments."

Preferred and Deferred Ordinary Stocks.

In terms of the "Regulation of Railways Act 1868," any Company which, in the year immediately preceding, has paid a dividend on its Ordinary Stock of not less than 3 per cent., may, pursuant to the Resolution of an Extraordinary General Meeting, divide their Paid-up Ordinary Stock into two classes, to be, and to be called, the one Preferred Ordinary Stock, and the other Deferred Ordinary Stock.

Preferred and Deferred Ordinary Stock are to be issued only in substitution for equal amounts of Paid-up Ordinary Stock. Preferred Ordinary Stock is allowed by the above Act to bear a fixed *maximum* non-cumulative dividend at the rate of 6 per cent. per annum; while the Deferred Ordinary Stock receives the balance of dividend payable on the Ordinary Stock over and above the fixed rate payable to the Preferred Ordinary Stock.

Taking the Caledonian Railway, for example, we find that a shareholder may at any time require the conversion of £100 of *Ordinary* Stock into £100 of Preferred Ordinary Stock and £100 of Deferred Ordinary Stock. The Preferred Ordinary Stock is entitled to a dividend at the rate of 3 per cent. per annum, and as the Ordinary Stock last year received a dividend of 5 per cent. for the year, the dividend on the Deferred Ordinary Stock last year was 2 per cent. Had the dividend on the Ordinary Stock been 3 per cent., the Preferred Ordinary would still have received its 3 per cent. and the Deferred Ordinary would not of course have received any dividend. Had the dividend on the Ordinary Stock been only 2 per cent. the Preferred Ordinary Stock would have received that rate also, and could not have claimed for the 1 per cent. short paid out of the profits of any subsequent year.

The Caledonian Railway have also two other Deferred Ordinary Stocks. Deferred Ordinary No. 1 participates *pari passu* with the Ordinary Stock in all the dividends above *seven* per cent.; and Deferred Ordinary No. 2 in all dividends above 9 per cent. Neither of these stocks has yet received any dividend.

Preference Stocks.

These are numerous, and very varied in character. Most of the Railway Companies have several classes of Preference Stocks, which have been created at various times, and all of which are entitled to

dividends at certain fixed rates before the Ordinary Stock receives any dividend. Among themselves, these Preference Stocks receive their dividends in a fixed order, but all of them come after the Debenture Stocks. Preference Stocks created since 1859 are dependent for dividends upon the profits of each separate year, but this arrangement does not affect pre-existing Accumulative Stocks, which have since 1859 been funded into new Accumulative Stocks. By "Accumulative Stocks," or "Stocks with Dividends Cumulative," is meant that, if in any one year there is not sufficient income to meet the claims of these stocks for dividend at the rate assigned to them, they can claim for unpaid dividends, or unpaid portions of dividends, for past years on the income of subsequent years. Other Preference Stocks are dependent for their dividends on the income of each separate year, and, if such income is insufficient to meet their claims in full, they cannot claim for arrears on the income of subsequent years.

Dividends Cumulative.

The Scotch Trustee Act, it will be seen, allows investment only in Cumulative Preference Stocks, and it further requires that such Stocks shall be those only of Companies in Great Britain, which have paid for the last ten years a dividend (without specifying a rate) on their Ordinary Stock. The English Act, on the other hand, allows investment in any Preference Stocks of Railway Companies of the United Kingdom, provided such Companies have paid for the past ten years a dividend of not less than 3 per cent. per annum on their Ordinary Stock.

Debentures and Debenture Stock.

The paper by Mr. Coles in the 15th vol. of the *J.I.A.* on "Railway Debenture Stock" has been already referred to, and some of the remarks in that paper will be reproduced under this heading. The fact that, as shown in our Table on page 57, 24 per cent. of the total sum invested last year by the Life Assurance Companies of the United Kingdom was placed in Debentures, should naturally lead us to examine this portion of our subject somewhat fully.

In Cavanagh's *Law of Money Securities*, a Debenture is defined as an instrument in writing, generally under seal, creating a definite charge on a definite or indefinite fund or subject of property in favour of a given person, or of a given person and his order or bearer, and constituting a member in a series of similar instruments, each entitling the original holder thereof to similar rights. Hence a Debenture is distinguished (1) from a Mortgage, which is an actual transfer of property; (2) from a Bond, which does not directly affect property; and (3) from a mere charge on property which is individualised, and

Definition of a Debenture.

does not form part in a series of similar charges. Speaking generally, we may say that a Debenture is a promise to repay at the end of a specified period, with interest meantime at an agreed-upon rate, an advance secured by the whole property of the individual or company, unless anything is stated to the contrary. Where any special security is pledged, the term "Mortgage Debenture" is generally made use of.

Form of a Debenture Bond.

The usual form of a Debenture Bond is that of a Mortgage deed assigning as security for the Loan the undertaking, tolls and sums of money arising under the Special Act of Incorporation. The Bond is transferable by deed only, duly stamped, the consideration-money being stated therein, and the transfer registered at the office of the Company, within a certain period after its date.

Security afforded by Debentures.

There is no doubt that where a specific Trust has been created, Debentures and Debenture Stock afford an investor a superior security, not only from the fact that they constitute a first charge, but also because they give him the advantages of a creditor, and do not saddle him with the liabilities of a shareholder. Care must however be taken in dealing with the Debentures of commercial companies when the undertaking is valued as a going concern; as, in case of a falling-off in trade, it will generally be found that mere buildings and plant form a very poor security, apart from the business itself.

Term "Debenture" misleading in certain circumstances.

In many commercial undertakings, the use of the term "Debenture" is frequently very misleading. Instead of some specific security being pledged for the debt, as would seem to be suggested, a charge over the general undertaking is all that is given, with the result that assets nominally mortgaged are notwithstanding left free to be dealt with as formerly.

Railway Companies, in the earlier days of their history, used to borrow a good deal of their capital by way of Debenture Bonds, not that they probably contemplated the actual repayment of the capital, but rather with the idea of re-borrowing when the Bonds matured. Finding, however, that difficulties and anxiety very often attended the re-borrowing, especially if the market happened to be in an unfavourable state at the time, they ultimately came to adopt the expedient of "funding" their Debenture Debt under the name of Debenture Stock.

In terms of the Companies Clauses Act 1863, when a Company is authorised, by its special Act incorporating that Act, to create and issue Debenture Stock, it may, with consent of the proportion of its shareholders named in its special Act, or, if no proportion be named, then with consent of three-fifths of its shareholders, issue Debenture Stock for such money as they have power to raise

on mortgage,—the rate of interest to be as fixed in the Special Act, or, if no rate be named, then at a rate not exceeding 4 per cent. Debenture Stock, with the interest thereon, forms a charge upon the undertaking of the Company prior to all Shares or Stock of the Company.

Interest on Debentures has priority of other Dividends.

Interest on Debenture Stock has priority of payment over all Dividends or Interest on any Shares or Stock of the Company, whether Ordinary or Preference or Guaranteed, and ranks next to the interest payable on the Mortgages or Bonds for the time being of the Company legally granted before the creation of such stock, but the holders of Debenture Stock are not as among themselves entitled to any preference or priority.

Holders of Debentures and Debenture Stock, in common with other shareholders, have the right to *examine*, at all reasonable times, the Register of Mortgages of the Company; and a decision, given only a few days ago, proves that they have also the right to *make a copy* of the entries in such Register.

Appointment of Receiver or Judicial Factor.

If interest on Debenture Stock is not paid within thirty days of its due date, any one or more holders, holding the amount prescribed in the special Act, and if no amount is prescribed, then *one-tenth* of the amount authorised to be raised on Mortgage, or £10,000, whichever of the two sums is the smaller, may require the appointment, in England or Ireland of a Receiver, and in Scotland of a Judicial Factor.

Debenture Stock does not give power to vote.

Debenture Stock does not give power to vote at meetings, but shall be considered as entitling holders to the rights and powers of mortgagees of the undertaking, other than the right to require repayment of the Principal Money paid up in respect of the Debenture Stock.

Application of money raised by Debenture Stock.

Money raised by Debenture Stock must be applied exclusively in paying off money due by the Company on Mortgage or Bond, or else for the purposes to which the same money would be applicable if it were raised on Mortgage or Bond instead of in Debenture Stock.

Debenture Stockholders cannot realise their Security or interfere with working of a Railway.

It was decided that the holders of Railway *Debenture Bonds* had the first claim on the net earnings of a railway, without, however, any power to seize the fee-simple of the land on which the Railway is constructed, or in fact to interfere with the carrying capabilities of the Railway. Accordingly, Railway Debenture *Stock* taking the place of Debenture Bonds, the holders of it become entitled to the first claim on the net earnings of the Railway for dividends, and take priority in that respect over the holders of the Ordinary and Preference Stocks, but they have no power to realise their security or to interfere with the working of the Railway.

Amount authorised to be borrowed on Debentures.

The amount to be borrowed by Railway Companies on Debentures is usually limited to one-third of their Share Capital.

Dealings in Debentures, as distinguished from Debenture Stocks, are subject to the following Stock Exchange Rule:—Bonds and Debentures of Railways in Great Britain, Ireland, and the East Indies, shall be dealt in so that the accrued interest up to the day for which the bargain was done be paid by the buyer; but bargains in Bonds and Debentures of Colonial and Foreign Railways shall include the accrued interest in the price.

Stock Exchange Rule as to dealings in Debentures.

Lloyd's Bonds.

In dealing with Debentures, we are naturally led to consider the form of security known as Lloyd's Bonds. They are not so familiar to investors as the other Stocks we have been dealing with, and the reasons that they are not more dealt in seem to be because they are to some extent uncertain in their nature—owing to their liability to forgery,—and because they come very near to being a means of evading the law.

Though by the "Cheap Trains Act" Railway Companies are prohibited from borrowing money otherwise than under the provisions of some Act of Parliament, "there is no rule of law or Act of Parliament to restrain them from the exercise of the general freedom of contract enjoyed by private persons. They are therefore at full liberty to purchase property or hire workmen, etc., and debts so incurred avail against the Corporation as they would against an individual debtor, and as such may be secured by covenant or charge on property. Thus a Railway Company may give a Bond or Debenture binding itself to repay a debt for work done or materials supplied, and such a Bond is as good and effectual as a security issued in direct pursuance of borrowing powers. An instrument by which debts of the nature described are secured, whether by covenant or by charge on property, is usually called a Lloyd's Bond" (Cavanagh). While, therefore, a Lloyd's Bond given to secure a present advance is illegal and invalid, it will stand good if given to secure a debt other than for money advanced, or even to secure a debt for a past advance which has been *bona fide* made and subsequently applied for the use of the borrowing body. Priority of claim between Lloyd's Bonds and Statutory Debentures appears to be only a question of more or less diligence. Originally no Coupons were attached to these Bonds, but latterly Coupons have been issued with them. It would seem to follow from what is here stated, that, by means of Lloyd's Bonds, the property of a Railway Company or other body corporate might be

indefinitely charged and its liabilities indefinitely increased, even though there is a restriction imposed by Act of Parliament on the borrowing powers of the Directors.

Lien Stocks.

"In its most general signification a Lien may be defined as a right to retain possession of, or judicially realise, the property of another, so long as a debt or other money demand due—either in respect of such property or otherwise—by the owner to the person claiming to exercise the right shall remain unsatisfied. A lien must be carefully distinguished from a Mortgage, Pawn, Assignment, or Charge; in common with these latter a lien is a security on property, and, so far as it extends, an encumbrance thereon, but the property affected by a mere lien is never in any way during the continuance of the lien transferred to the person holding the same, although such person may in many cases be entitled by means of his lien to have the property transferred or realised in his favour" (Cavanagh).

Like other forms of property, Railway Lines may form subjects of liens. Railway Lien Stocks seem to have originated in most cases from amalgamations. On the transfer of a smaller line to a larger Company, the shareholders of the transferred Company are guaranteed a fixed rate of interest on their capital by the Company taking over their undertaking, and they retain at the same time a lien over the transferred Railway as a further security for payment of future dividends.

We have already seen that the holders of *Railway Debentures* or *Debenture Stock* have no power to seize the fee-simple of the land on which a Railway is constructed, or to interfere with the carrying capabilities of the Railway, but are only entitled to the first claim on the net earnings of the Railway for dividends. It appears, however, that "a vendor to a Railway Company has the same lien and remedies as an ordinary vendor; that such lien will be enforced by sale although the Railway be made and open for public use; that the sale will be made free from all claims of the public to use the line as a highway; but an interlocutory injunction to restrain a Company from running their trains until the lien is discharged will not be granted; nor, according to the most recent decision, a receiver appointed, though such an indulgence was formerly granted" (Cavanagh).

Leased and Rent Charge Stocks.

Analogous to Lien Stocks are the Stocks of Leased Lines. Such lines are usually of small extent, often mere connecting links

between different systems. It is much less expensive as regards management and working to lease them to some large Company. The term of the lease is usually for a longer or shorter number of years, and very often in perpetuity. A certain yearly payment in name of rent is made by the leasing Company, and, as the original shareholders never actually part with their property, they have always their own undertaking to fall back upon in the event of the leasing Company failing to pay the agreed-on rent.

It will have been noticed that the English Trustee Act allows investment in Leased Stocks only if the lease is for not less than 200 years at a fixed rent; while the Scotch Act allows investment in such Stock only in those cases where a lien has been retained over the undertaking.

Rent Charge Stock.

By a Rent Charge we are accustomed to think of the annual payment required to redeem a sum of money, Principal and Interest, within a certain number of years. A Rent Charge Stock, however, does not imply the redemption of the capital in that way, and all that the name signifies, apparently, is that the annual payment of interest on the capital is of the nature of a rent for the use of the line.

Surplus Lands Stock.

We have now noticed all the chief *classes* of Railway Stocks. There are, however, special Stocks which are peculiar to certain railways, but we cannot examine all of these in detail. They are, as a rule, not very frequently met with, and in most cases their names indicate pretty clearly their characteristics. We shall just refer very shortly to the above-named Stock as an example of such Special Stocks.

The Surplus Lands Stock appears among the Stocks of the Metropolitan Railway Company, and it had its origin as follows: By their Act of 1885, the Directors of that Company were instructed to prepare a plan showing the lands which were not in their judgment required, or likely to be required, for the purposes of the railway undertaking. These lands were thereafter formed into a separate Stock, which is managed by a committee of three Stockholders and two Directors.

As the Debenture and certain other Preference Stocks existing at the date of formation of the New Stock had rights of priority in the lands in question, these rights are still of course protected under the new Stock.

We have already perhaps dealt with all of those Stocks in which the Funds of Insurance Companies are usually invested. There are, however, some other important classes of investment made use of, chiefly by private investors, to which we may refer in a word or two.

Trust Companies.

There are quite a number of these, and they are also very varied in character. Those of the better class have been formed "to invest money upon the security of real estate," chiefly in the Colonies and in the United States; "to invest in selected Stocks and Shares, and to average investments"; "to invest in various dividend-paying undertakings on the trust principle"; "to accept transfers into the name of the company and trustees of ordinary Stocks of certain railway companies, and to issue their own shares in exchange for the same"; "for the purpose of applying to lands the principle of division of risks and an averaging of profits"; "to purchase assets of bankrupt estates," etc. etc.

In addition to their ordinary shares they very frequently issue Preference and Debenture Stocks also.

Bank Shares.

These, no doubt, form safe enough investments, so far at least as the principal Banks of the United Kingdom are concerned; but the great drawback to them undoubtedly is, the large uncalled liability which is still in most cases attached to the shares. Previously to the disastrous failure of the City of Glasgow Bank most of the Scotch Banks at least were altogether unlimited; but now all that were not formerly limited have been registered with limited liability under the Companies Acts 1862 to 1880. In some cases the uncalled capital is capable of being called up only for the purpose of liquidation; and in other cases part of it may be called up for business purposes and part for liquidation. It is of course quite outside the scope of this paper to refer to the important and interesting subject of the business of Banking.

Insurance Shares.

Little need perhaps be said about these. Most of us who are connected with Proprietary Companies are already familiar with the shares of our own offices. Though Assurance Companies do not hesitate to purchase the policies of other offices as an investment, it is, I suppose, unheard-of for one company to invest in the *shares* of another. Many companies hold their own shares as an investment, though the propriety of their doing even this has been

called in question. It is somewhat remarkable to observe how very large an uncalled liability attaches to the shares of Insurance Companies without exception. Circumstances seem to be combining to make insurance shares a less desirable investment than formerly; and in the case of purely Life Offices, at any rate, it is safe to say that the same dividends are not likely to be paid on them in the future as in the past.

Commercial Companies.

Investors who are not speculators do not usually deal in the ordinary shares of such Companies; but of late the debentures of many of them have come into considerable favour. We have already referred in part to these under our heading of Debentures and Debenture Stocks, and I would conclude these remarks upon Shares of commercial Companies now, by quoting two or three sentences from a paper by Mr. Mackenzie in the *Journal of the Institute of Actuaries*, vol. xxix. He says: "As regards Preference Shares or Stocks of commercial companies, it is certainly safer to avoid all new companies, and only to invest in them when the ordinary capital is proportionately large, when steady dividends have been paid, and where there is nothing in the nature of the business carried on to render future profits uncertain. Even the Preference Shares of companies whose earnings may not improbably be affected by the future course of legislation should be avoided. Many breweries and distilleries, for instance, are dependent for much of their profit upon 'tied houses,' and the fact of there being a strong desire in many quarters for a reduction in the number of public-houses should not be overlooked."

American Securities.

We have dealt throughout this paper almost entirely with Home and Colonial Investments, but there is no doubt that our Assurance Companies are already finding even that pretty wide field too narrow for their needs as regards investments. Several of them, it is well known, have lately placed large sums in mortgage over property in the United States, and others have been taking up somewhat freely the better class of American Railway Bonds.

Gold Bonds, Currency Bonds, Sterling Bonds.

These Bonds are of three descriptions, namely, *Gold* Bonds, *Currency* Bonds, and *Sterling* Bonds. *Gold* Bonds are so named because they contract to repay principal and interest in gold dollars. *Currency* Bonds are repayable in the lawful money of the United States at the time, whatever that may be. *Sterling* Bonds are issued in British currency to suit them for the home market. The difference between

the *Gold* and *Sterling* Bonds will thus be just the difference of exchange at the time.

The American Securities to which we have referred may be perfectly safe for investment, and the higher rate of interest realisable on them meantime undoubtedly forms a great attraction to them. It is to be borne in mind, however, that there are various weighty considerations to justify many of those who are responsible for the investment of our Assurance Funds in their decision to have nothing to do with American Securities. We shall close this head of our subject by merely mentioning some of these:—(1) In the event, which we all hope will be remote, of war between this country and the United States, the interest on investments in America would cease for the time at least to be payable; (2) American laws and institutions have been shown to be liable to sudden and very great alterations; (3) Many of the existing laws are already decidedly unfavourable to *aliens*, and the tendency seems to be to make all of them so. For instance, some of the States have already passed a law whereby, in the case of a bankruptcy, the claims of creditors *within* the State must be met in full before any outside creditor gets any part of his claim paid. The legislature of the State of California has also, I am informed, passed a Bill—which only wants the signature of the Governor to make it law—whereby the Governor is empowered, in certain circumstances, to *confiscate* alien capital; (4) There has been for some time past, and there is at present, a widespread agitation to get alien capital heavily taxed, and there is little doubt that, when such capital is less required in America than it is at present, some measure to that end will become law; (5) Many of the American States have in former times repudiated their liabilities to their creditors, and some of them may do so again; (6) It must be said also, though with reluctance and regret, that there is a great tendency in America to think lightly oftentimes of certain forms of what, to give it its most respectable name, we must call sharp practice in business matters, especially in the case of syndicates; and investors there have therefore need to exercise very great caution indeed as to the character of the parties to whom they intrust their capital; (7) As in the Colonies and elsewhere of late the rate of interest has suffered very great diminution, so it is to be anticipated that the higher rates of interest presently prevailing in America are not likely to be long-lived either.

It now only remains to me to close this, which I feel to be a somewhat imperfect, sketch, by mentioning the sources from which I have drawn much of the information contained in the paper, or from which I have obtained useful hints. They are: *Burdett's Official Intelligence*, *The Stock Exchange Year-Book*, *Fenn on the*

Funds, The Encyclopædia Britannica, Cavanagh's Law of Money Securities, and various pamphlets, chiefly the paper on "Life Office Investments," read before the Society on 7th March 1895, by our Honorary President for the present year, and a paper by Mr. Graham Watson, Manager of the Scottish Provident Institution, on the "Consideration of Securities for Loans," read before the Chartered Accountants Students' Society three years ago.

INDEXED

Some Medical Aspects of Life Assurance.

BY

LESLIE OGILVIE,

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Some Medical Aspects of Life Assurance.[1]

MR. PRESIDENT AND GENTLEMEN,—I accepted with some misgiving the invitation with which your President honoured me to read a paper before your Society on some medical subject connected with Life Assurance, because I doubted my ability to deal with it in any way worthy of the audience. When I further reflected that some of those present might be the Managers and Actuaries and even the Chief Medical Officers of Companies for which I have examined in London, I sought a loophole for honourable escape. Now, when the eyes of some of these officials are upon me, I feel inclined to beat a dishonourable retreat.

Many valuable contributions have been made to this subject, and subjects bearing upon it, of late years; and if I gave you an account of the bibliography alone, it would occupy the time at my disposal. The President probably thought that the study of this literature would be of educational advantage to me; and, if so, I can assure him that it has fulfilled the object he had in view.

The title of *Some Medical Aspects of Life Assurance* seemed to be one which would enable me to escape the dangers of attempting to give you a statistical dissertation on my own experience, while it would admit of some general remarks on the method of Life Assurance examination.

I am addressing a Society of professional men on a complex subject, about one side of which I am supposed to know something indefinite, while the other side is known definitely by them. You can tell me, for example, by looking up a Life Table, how many of ten thousand people born will be alive in twenty, forty, fifty years, and when a hundred of them are to die; and you invite me to tell you how to reduce in some measure my part of the subject to the same mathematical exactitude, and, without looking up a Table, to say how long a particular individual is to live and when he is to die.

My object this evening is to disclose a part of this secret. To suit the actuarial mind I have tried to produce some kind of tabular scheme illustrating the principles which have guided me in my

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[1] Read before the Actuarial Society of Edinburgh on January 14th, 1897.

insurance work. The algebraic signs may perhaps be pleasing to your eyes.

The day is probably still distant when reduction to an exact formula for each case will be worked out by the Actuary and the Medical Officer together. Towards the end of next century, perhaps, the whole process will be performed by machinery, the Actuary having worked out his own destruction by the mathematical accuracy of his tables and formulæ. But the Doctor, doubtless, will still be retained to put the items of medical information in the slot.

Gentlemen, I think I am correct in saying that in some respects the methods and forms of medical insurance examination are in advance of what they were fifty, or even twenty-five years ago. More attention is now paid to details of physical examination than in former days, and advances have been made in the methods of making such investigations. Take, for example, *the urine*. The day was when the urine was not examined at all, or only occasionally. Then there came a time when any trace of albumin was regarded as an indication of Bright's disease, and the presence of sugar as a certain sign of diabetes—both these conditions entailing the absolute rejection of the proposer. Nowadays we hesitate to say without further and more accurate examination what is the exact significance of the presence of either of these substances in any particular specimen. With more exact tests we differentiate one kind of albumin from another, and we recognise that all is not sugar which reduces Fehling's solution. We resort more frequently to microscopic examination in cases of doubt, and negative results as regards the presence of tube-casts, blood and other cells, and certain crystals, make us look more favourably on cases of albuminuria, especially where the albumin is ultimately proved to be intermittent.

I think it is now recognised that albuminuria can exist without obvious renal changes. Grainger Stewart and others consider that a physiological albuminuria may follow muscular work, emotional excitement, a rich albuminous diet, dyspepsia, cold bathing, etc. All observers, however, are not agreed on this point. I am inclined to think that the presence of albumin is indicative of some change in the epithelium or lining of the tubules of the kidney, though it may be often transient and of small importance. Such temporary and slight changes are observed on the epithelial surfaces of other internal organs, such as the stomach, bowel and bronchial tubes, and on the surface of the skin, which is akin to these in structure, and leave no permanent effects. The febrile albuminuria in pneumonia, typhoid, diphtheria, acute tonsilitis, pregnancy, etc., rarely leads to a permanent alteration, and there may be other conditions not associated with symptoms of ill-health which produce temporary alterations in the functional activity and minute structure of the kidney.

I am happy to be able to look back to some cases of functional or cyclic albuminuria, or albuminuria of adolescence, which, after careful and repeated examination of specimens passed at different times of the day, were recommended by me at a small extra ten years ago, and the premiums are still being paid. I have, in fact, so far no record of death in these cases.

Shattuck points out:—(1) That renal albuminuria, as proved by the presence of albumin and casts, is much more common in adults, quite apart from Bright's disease, than is generally supposed; (2) That, though as yet not absolutely proved, it is highly probable that faint traces of albumin and hyaline and finely granular casts of small diameter, especially in those past fifty, are often of little or no practical importance.

Personally, however, I have hesitated more to pass a man above forty with albumin than one below thirty with the same condition. I go so far as to say that few cases of albumin in the urine should be rejected offhand without careful examination as to the persistence of the condition and the nature and source of the albumin, unless, of course, the condition of other organs—such as the heart and blood-vessels—indicate the probability of kidney disease.

Osler says that "After the fortieth year, from the standpoint of Life Assurance, the state of the arteries is far more important than the condition of the urine." He evidently agrees with the acute observation of a wise physician, "A man is only as old as his arteries."

Nowadays the Insurance Offices can obtain exhaustive reports and analyses of urine from clinical laboratories; and I would advocate the more frequent use of researches of this kind in cases of doubt—at the expense of the Offices, of course—as the Medical Officer cannot be expected to apply more than the usual tests in the limited time at his disposal. Analyses of fluids and microscopical investigations are thus made with thoroughness by specially trained men by means of reagents and apparatus not at the immediate disposal of the Medical Officer of an Insurance Company. The physician in private practice and in hospital work avails himself more and more of such expert aid; and I am convinced that, if the Insurance Companies adopted the same course, fewer cases of injustice to proposers would occur, and the Offices concerned would be correspondingly benefited.

Before leaving this subject I am forced to confess that the examination of one specimen of urine enables the doctor to give only a rough estimate of the probable condition of the kidneys. For example, a low specific gravity may really be permanent and of great significance; still we cannot ask the proposer whose urine is otherwise normal, and who shows no other signs of disease, to come again and again for the purpose of proving that the condition

was only temporary. But, as I will show later on, it is the *personal* element which really guides the physician in judging of the need for re-examination.

I may be told that, with all our vaunted new methods and more exact knowledge, the estimation of the value of lives is no better than it was under our predecessors fifty or twenty-five years ago. This may be so; but every item of exact medical knowledge must ultimately be a gain to Insurance Companies. I grant that there is a danger with this attention to minutiæ that we may fail to cultivate that habit of observing the general appearance of proposers which guided our forefathers most of all, and thus be led to pass or reject a life with only a passing glance at the applicant. In Life Assurance examinations more than in private practice, where there is usually opportunity for re-examination, there is a certain professional tact to be acquired to enable the doctor to gauge the value of a life. He must appreciate the essential points of the case quickly, and give a decisive opinion; the perceptive powers must be specially cultivated in addition to pure professional skill. How common it is to hear the remark by a keen lay observer, "So-and-So does not look like dying," though the doctors have given him up owing to the presence of adverse physical signs. Daily experience of the world, common-sense, and a certain amount of medical knowledge have doubtless ere now enabled some of my present audience to give occasionally a wise prognosis in cases of Life Assurance. We cannot, however, depend entirely on this prophetic strain, and must seek other and more reliable methods as well in gauging the value of a life. The power of intuition can only be gained by those who have, by long use, trained their special senses and their judgment, though simple experience may occasionally triumph over that gained by the laborious acquisition of scientific knowledge. The medical examiner is probably none the worse of having a spice of Sherlock Holmes in him. All he can do is to give an estimate of *the probabilities*. The aphorism of Hippocrates that "Life is short; Art is long; Experience is deceptive; Judgment is difficult," is as true to-day as it was more than twenty centuries ago.

In thus drawing special attention to the value of general observation of the proposer, you must not understand me to decry the absolute importance of all or any of the artificial aids to the discovery of his physical condition, to some of which I have referred already. Indeed I began by pointing out that advances had been made in this particular in examination for Life Assurance; and in fact, so far, I have only tried to show that in my opinion almost as much importance is to be attached to the general appearance of the proposer as to his physical condition determined by the best methods of clinical investigation. Observa-

tion as to the most trivial modifications of complexion, voice, expression, manner, gait, or muscular control, etc., have to be carefully noted as well as the exact physical signs.

I believe that in most medical forms more space should be left for the description of the proposer. The space of a page is usually given for the personal history, another for the family history, and *one line* for the general appearance of the proposer. Some Companies—whose names I need not mention—sin especially in this respect. The directors are therefore asked to picture to themselves the proposer from monosyllabic descriptions such as "fair," "dark," "thin," "stout," "paunchy," etc., with a few statements as to height and weight,—often inaccurate. It is probable that the experienced examiner finds space elsewhere to fill in his description; but the novice in Insurance examination only answers what he is asked in the space allowed. I do not think you can expect a perfect literary word-picture at the price; but more might often be given if space were allowed.

After all, the Medical Officer is invited as an expert to give a description of the goods and his estimate of their value. The directors are, from one point of view, the purchasers. The mere advice not to buy may do the seller injustice, and we have to consider him as well as those who employ us, although we must give them the first consideration. They naturally desire a short statement—the shorter the better—of the expert's reasons to enable them to form an independent judgment.

In estimating the value of a life, we have to investigate the case from five different points of view, viz.:—

(1) The personal history; (2) The family history; (3) The physical condition as ascertained by careful medical examination; (4) The personal appearance; and (5) The environment, including habits and mode of life.

The relative value of each item is probably a matter of opinion, but I am inclined to give them the values indicated on the Table I show you, which likewise indicates the method I find useful in rapidly recording the salient features of the insurance cases which come under my notice.[1]

I fail to see how the statistical method alone is available with so many conditions to consider. Each individual has to be considered separately, because few cases are even similar when viewed from all these aspects. The statistical method has proved most useful in surgical cases, because diagnosis is naturally more accurate in these than in medical cases. Medical statistics can never become so mathematically exact as general vital statistics; but, at the same time, we are receiving year by year, especially from the statistics of Life Assurance Companies,

[1] *See Table* at page 113.

valuable information. The medical analysis of the statistics of Life Insurance Companies is a matter of great difficulty; but I have often thought that the most valuable information on the subject of Life Assurance is actually buried in the safes of the Companies.

Professor Laycock says that the numerical method "admits of only very limited application to individual cases, inasmuch as special conditions may be at work in these not taken into account in numerical estimation. A complex numerical estimate of special conditions in each case is necessary."

The medical man who acts most successfully on wide experience takes in the broad aspects of each case, and accurate statistics are rarely called to his service. They could not help him to know whether the individual case attacked with pneumonia, for example, is to be classed with the four-fifths shown numerically to recover or with the one-fifth who die?

There can be no doubt as to the great uses of statistics. The investigation of the Associated Scotch Life Offices into the mortality of liquor-sellers is an admirable example of this. We must realise, however, that erroneous deductions from them are more apt to be made when we come to deal with individual cases instead of with a whole class. You may tell me the percentage of deaths from consumption of the whole community, and calculate the probable age of death, the number of those who had tubercular ancestors, the proportion of them who have shown early in life the tubercular diathesis; but, although the facts obtained are valuable, you have gone very little way in guiding me to give you an opinion as to the relative value of the prospects of life of *A* and *B*. They are of the same age; both have had signs of pulmonary delicacy; both had a tubercular father; neither shows signs of disease of any organ at present: but, from the general appearance and general surroundings and habits of *A*, one must class his prospects of life as superior to *B's*.

It might be well now to discuss more fully the relative importance of the items which are considered in estimating the value of a life.

I may say that the values attached to each head have been arrived at partly as the result of my own personal experience in Life Assurance examinations.

The subject of heredity has been discussed of late by gentlemen connected with Life Assurance. Mr. Mogridge Hudson, for example, has written a pamphlet on this subject in which he attempts to prove "the improbability of disease being hereditary." He says, "When we come to the question of disease being hereditary, which embraces so many studies outside ordinary medical training, the medical man's opinion is not that of an expert." He considers that the medical man's training "is, perhaps, the

least scientific of all trainings." Gentlemen, after carefully reading Mr. Hudson's pamphlet, I am sure he will not take offence if I say that it seems to me that there are other sections of the community whose scientific training is defective; and I would on the whole prefer to trust to the result of Mr. Jonathan Hutchinson's observations, which have enabled him to come to the following conclusion in reference to inheritance in tuberculosis. "It is impossible," he says, "for any one acquainted with the facts to disbelieve in the power of hereditary transmission and rest only on the theory of contagion from without. The subject is one much too complicated to be well suited for illustration by statistical observations; these are as likely to mislead as to help us."

Owing to the great importance of the subject, I am tempted to refer to it at some length while considering the first two heads more or less together—that is, the personal and the family history. And, as an introduction, I would like to refer to an able and interesting paper by Dr. Rabagliati on "The Preponderating Importance of the Personal History as compared with Heredity in Life Assurance." Although I am unable to agree with all that he has said, I feel that his paper is at least a plea for the equal recognition of personal history with family history. It is, as I understand it, not only the proposer's health record, however, which he takes into consideration, but his habits and his circumstances, and he represents these as much more important than the history of his ancestors. But he does not make this quite clear. For example, he says, information of value for life assurance "is almost wholly to be obtained from inquiries about the personal history of the applicant, and very little from inquiries regarding his ancestors." He repeats this statement as follows:—"In gauging the value of lives for assurance at least nine-tenths of the dangers arise from personal considerations, and only one-tenth from family history." He even thinks that nineteen-twentieths is the proportion of the one and one-twentieth the proportion of the other. He considers that "disease is very little hereditary: that *disease* is not transmitted, but *organisation* is"; and he asks, "Why should we betake ourselves to unproved hypotheses regarding hereditary transmission?" These are strong statements; and he brings forward no facts to support his opinion. He speaks of "organisation being transmitted." Certainly, I say; and no one denies that each animal gives origin only to creatures of the same species, and therefore of the same organisation. Human beings, for example, do not produce progeny with the organisation of lobsters. Not only the gross features of the body are transmitted, but the intimate structure of every organ. Each variety of cell of which the body is composed inherits its own special function and its own special form. Nerve, blood, and epithelial cells are unlike each other in

form, and they are incapable of performing each other's functions. A nerve cell, for example, could not possibly manufacture pepsine, which is only produced by the epithelial cells of the stomach. These three types of cells being developments of three different cellular layers of the embryo, inherit tendencies to grow in special directions. It is not too much to assume that the vitality of the ovum and spermatozoon determines the vital energy of the cellular layers to which, by their union, they give origin; and that *their* weakness or strength is in turn transmitted to those structures of the body into which they develop. The ovum and spermatozoon are merely free specialised cells of the parents, and are likely to share in the debility or well-being of the other cell structures of their bodies. The tendency to early degeneration is surely transmitted! Thus we recognise in different families a tendency to different kinds of degenerations. In one the tendency is for the muscle cells to degenerate into fatty cells; in another the tendency is for certain cells to multiply in an abnormal manner, producing, for example, epithelial growths, such as cancer of the lip, tongue, stomach, or uterus, the same part being not unfrequently attacked in three generations; in a third there is shown a tendency to the formation of fibrous tumours from what are essentially cellular structures. We are forced to conclude, therefore, that some local weakness has been inherited.

No one can deny that a healthy father and mother are more likely than weakly parents to produce offspring in which the cells of the body are normal in form and function. Derangements of the mucous surfaces of the stomach, bowel and bronchial tubes often declare themselves soon after the birth of children whose parents are prone to suffer from these maladies. This surely goes to show that some enfeeblement of the epithelial cells lining these surfaces has been transmitted. So also enfeeblement of the nerve cells is shown soon after the birth of children before environment could possibly produce such degeneration. It is not always irregularity of diet but often a hereditary bias which is responsible for the numerous instances of eczema and kindred skin diseases which occur soon after birth in children whose parents have shown the same tendency.

I have records of two families in which psoriasis occurred in childhood in three generations. The cases belonging to the first family came under my notice in hospital practice, three children out of six having psoriasis similar to that from which their mother and grandmother suffered. The second was a family of well-to-do people where a son and daughter developed the disease in infancy, the father and grandfather having previously suffered.

We recognise now that PARASITIC GERMS produce a great variety of diseases. We probably all breathe the tubercle bacillus at

some time or other, but only some are infected. That immunity exists in others is shown by the fact that the *bacillus tuberculosis* is sometimes found in the nose of those attending cases of phthisis; that the bacillus of diphtheria has been found in the throat without producing the disease; and that the pneumonia germ is sometimes seen in the sputum of healthy people. It is probable that an inherent weakness in certain cellular structures, or a different chemical constitution of the tissues and fluids of the body, explains the so-called disposition to the development of tubercle in some. May the bacillus be inherited, or is it the inability to withstand the inroads of these organisms which is handed on? If the latter, is this inability due to a temporary enfeeblement of health in the father or mother from any cause, or only from actual tuberculosis in them?

The hereditary transmission of tubercle by direct intra-uterine infection has been proved in several cases experimentally and clinically. Tubercle bacilli have, for example, been found in the fœtus, as certainly as have the bacilli of typhoid. These tubercle bacilli may remain dormant in the tissues of the child for years, to become active later on.

In the discussion in the Royal Medical and Chirurgical Society of London last year on "The Latency of Parasitic Germs or Specific Poisons in Animal Tissues," the greatest authorities agreed that such latency had been actually proved.

It has been shown clinically and pathologically that tuberculosis in the lungs has been arrested and remained latent for years to break out again by reinfection from within, the old lesions being the foci of infection. Seeing, then, that these bacilli have been found in the fœtus, it is not too much to expect that prolonged latency might lead to the outburst of tuberculosis in adult life after direct transmission from the mother *in utero*.

Dr. Kingston Fowler in that discussion said:—"It may, I think, be considered as fully established that it is possible for a tubercular mother to infect her child; but it is a long step from this to the acceptance of Baumgarten's view that this is the common mode of infection in tuberculosis. I am disposed, however, to believe," he continued, "that in the future evidence will accumulate in favour of the view that in some cases of tuberculosis of the glands, bones, and joints which occur in childhood the virus has been directly transmitted from parent to child, and has remained latent in the tissues of the child. Many of these cases are difficult to explain on the assumption that infection is from without."

Such examples of direct transmission of organisms are cases of pure infection just as much as if it had occurred in *extra*-uterine life, and are better described as instances of congenital rather than of hereditary tuberculosis.

Gentlemen, Is there a hereditary transmission of a *proclivity* to this disease? If we consider other infectious diseases, it is difficult to explain the supposed greater tendency of the children of consumptive mothers to take the disease. In other infectious diseases if the mother is infected the fœtus either takes the disease or it is born with a lessened tendency to it. There is, as has been well said, a race between infection and immunity. For example, if a mother has smallpox, say two and a half weeks before the birth of the child, the child may be born with smallpox or it may contract the disease in early after-fœtal life by infection, or it may have acquired an immunity against the disease rendering successful vaccination impossible. So, again, if the pregnant woman is vaccinated, say three weeks before the birth of the child, the infant is less likely to be successfully vaccinated.

Infectious diseases often convey an immunity. It has been experimentally proved that an acquired immunity may be transmitted from parent to offspring. Why should tuberculosis, which is known to be an infectious disease, stand alone and convey LIABILITY? Has it been scientifically proved that it does convey such a liability more than any other debilitating ailment of the mother?

There are instances which prove that the longer a race is exposed to a special infectious disease the more power of resistance they acquire against it, as if an immunity was transmitted. Negroes, for example, are not susceptible to ague and yellow fever, to which they have been exposed for centuries; but the introduction of another specific fever to which they are unused plays havoc with the population. This occurred, for instance, when measles was introduced into Fiji, the West Indian Islands, and elsewhere.

Dr. Marsh, in an interesting paper on "The Value of Family History and Personal Condition in estimating a Liability to Consumption," points out that the statistics of the Mutual Life Insurance Company of New York show "that the percentage of deaths from consumption has been much larger in the tainted than in the non-tainted class, and that this increased proportion exists at every decennial period of life until extreme old age." He considers that his Tables also show "that both a history of phthisis in the family and the condition of personal underweight indicate increased liability to consumption, and that these factors differ considerably in the degree of their influence. The family history exhibits much less influence than the weight, and a good record of weight overbalances tainted family history. The combination of the two factors indicates the maximum and the absence of both the minimum of susceptibility." To me Dr. Marsh's Tables, though valuable, are inconclusive, if not fallacious, and I would hesitate to draw any trustworthy deductions from them. But I was certainly struck with the large percentage of deaths

from consumption in the non-consumptive families,—showing, perhaps, that a debility of the parents produced by other causes than consumption also transmits a liability to tubercular infection.

I think I can show you what I mean by telling you that he found that between the ages of forty and forty-nine, for example, 17·6 per cent. of the total number of deaths from all causes were from consumption in the *non*-consumptive families, while 24·6 was the percentage of deaths from consumption in the consumptive families. This shows an excess of 7 per cent. of deaths from this cause in the tainted, as compared with the *non*-tainted families. Of that 7 per cent. a certain number may have been, and probably were, directly infected by contact with their own family, some by contact with infected strangers, and others by direct intra-uterine infection, and the remaining small percentage —how small I cannot tell—would therefore be all that is left as due to inherited proclivity.

What is termed "late hereditary syphilis" also shows the possibility of inherited disease remaining latent for a long period of years. In such cases the child is born healthy and remains healthy to the age of puberty, and then shows the disease by such symptoms as typical malformation of the teeth (never seen in the first dentition), interstitial keratitis, deafness, disease of joints and bones, and nervous disorders. This combination of symptoms is at the present date (principally due to the keen observations of Mr. Jonathan Hutchinson) recognised as pathognomonic to such an extent that from them alone nobody will hesitate to make the diagnosis of hereditary syphilis, regardless of the previous known history of the patient or the parents. Again, children of syphilitic parents, although they have never presented any sign of the disease, have a diminished chance of living—often dying early from anæmia, atrophy, with symptoms of functional brain disorders, without the post-mortem examination revealing any cause; but surely these children, although, according to our present means of observation, they did not inherit the actual disease, inherited some lack of resisting power or lack of vitality. Fournier describes this disposition as *parasyphilis*, which he wishes to be understood as distinct from syphilis.

I need only refer to one or two examples of diseases *not considered to be due to parasitic germs*, by way of combating Dr. Rabagliati's conclusions.

It is well known that there are several diseases, such as pseudo-hypertrophic paralysis, hæmophilia, and hereditary optic nerve atrophy which are transmitted generally through the female side to the male members of the family. Leber gives an exhaustive history of the literature on the subject of the last-named disease.

Consanguineous marriages have been supposed by some to produce enfeebled offspring, not in virtue of the consanguinity itself, but because the chance of perpetuation of a delicacy in the family is doubled. What we know, however, about retinitis pigmentosa, or pigmentary degeneration of the retina rather tends to show that there is also something in consanguinity itself which produces delicacy in the offspring. Cases of this disease are known where no history of a similar ailment in the family is recorded. It is admitted by most ophthalmic surgeons that consanguinity is a frequent cause of this condition.

To sum up, I do not deny that perhaps in the great majority of instances it is not the disease itself which is inherited, but either an inability of the cellular structures of the body to resist the inroads of special organisms, or a liability to degenerate in special ways. This inability to resist infectious germs can, of course, be *acquired*. The development of consumption after influenza in a man whose family history shows no trace of the disease is an example of this. Direct infection is, without doubt, a common cause of phthisis, the enfeebled condition of the body of the sufferer being either inherited or acquired.

From the Life Insurance point of view I do not think it is of much importance whether individuals inherit the actual disease, caused by bacilli or otherwise, or whether they inherit an enfeeblement of certain structures of the body which makes them liable to such disease. The crucial question is, Do we, or do we not, inherit enfeebled or robust constitutions from our ancestors? I emphatically answer, Yes: and I therefore think that the family history is a consideration of great weight in medical examination for Life Assurance.

Certain diseases occurring in the *personal history* are, from the Insurance point of view, of the utmost significance; such, for example, as rheumatism, gout, appendicitis, renal and hepatic colic; because the tendency is for these to recur. Other diseases are, of course, equally important from the tendency which they indicate, or the gravity of the lesions which they leave behind.

The difficulty which we generally have is to determine the nature of the malady from which the proposer has suffered. "Some bowel complaint," for example, is a common term which may cover intestinal, renal, or hepatic colic, or appendicitis. Simple indigestion may be the prelude to cancer of the stomach or bowel. It is the duty of the medical examiner by cross-questioning to elucidate, as far as possible, the exact nature of the illness, or by reference to the medical attendant to obtain exact information as to its nature. With all these precautions, however, it is often difficult to obtain the information desired. The exact diagnosis of such ailments is, of necessity, even in actual practice,

difficult; and it is not extraordinary if the proposer, taking the most favourable view of the malady from which he has recovered, gives less exact information than the private patient.

It is impossible to refer in a general way to more than one of these. A consideration of the subject of *gout* would perhaps enable me to illustrate the relative importance of the personal and family histories (which I am inclined to rank as of equal value).

A thorough understanding of the nature of gout would go far to solve some of the mysteries of life itself. Hereditary influences doubtless play a considerable part. Some authorities consider that in 50 to 60 per cent. of the cases the disease existed in parents and grandparents. Garrod found that more than half of his gouty patients could prove inherited predisposition. Osler says that "cases of a strong hereditary taint have been known to develop before puberty. The disease has been known even in infants at the breast." This fact surely supports the probability of the inheritance of the predisposition to defective alkalinity of the blood, or whatever else is the true explanation of the gouty diathesis.

An acute attack of gout in the personal history of the proposer, and especially if there has been a family history of the same, is regarded by most Offices as entailing an extra premium. Do we know, however, the relative importance to be attached to an attack of genuine articular gout, and to those manifestations of the gouty diathesis, such as headache, eczema, indigestion, biliousness, etc., which are so often regarded as trivial ailments by the proposer? A man of naturally active habits may have an attack of gout if laid up through an accident, though his signs of a gouty diathesis or inheritance would have otherwise remained undetected; and we extra this man and not another who has shown some of the symptoms of irregular gout. It is not uncommon to find an attack of serious gouty phlebitis follow an operation or an injury in a man who had previously shown only indefinite signs of his tendency.

Irregular gout shows itself in such various ways that it is often very difficult to trace the symptoms to their proper origin. These irregular types are said to be perhaps more often seen in those who have the hereditary predisposition than in those who have acquired the disease. If this be so, it seems unfair to load the life of a man who has had typical articular gout, while others, merely confessing to torpid liver, slight eczema, gastro-intestinal disorders, headache, sciatica, urethritis, or other irregular symptoms, are passed at ordinary rates.

I am inclined to think that, although an attack of gout warrants an extra in some cases, it is a mistake to obey a hard and fast rule. I agree with Sir William Roberts, who says, "Nowhere,

perhaps, is it more necessary than in gout to consider the man as well as the ailment, and very often more the man than the ailment."

I have present to my mind cases which show that if we are to be consistent we must extra not only those who have a personal history of genuine articular gout with a family predisposition to it, but also those who, having such a family history, show, in the opinion of the Medical Officer, any of the various symptoms of the gouty diathesis.

I think we are able to gauge the type of man who is likely to become extremely careful of his health after suffering from an acute attack of gout or showing manifestations of that disposition. In my experience it is not unfrequent that a man who has shown about mid-age a tendency to this or to some other disease has altered his mode of life and enhanced his chances of longevity. I think we might often apply to physical habits the dictum which Shakespeare has applied to the moral tendencies: "Best men are moulded out of faults, and for the most become much more the better for being a little bad."

The man of somewhat full habit of body, with intermittent glycosuria, could perhaps truthfully say that he never had gout. Sugar may be absent from the urine at the time of examination, and he is passed at ordinary rates; but surely he is as essentially gouty, and a more doubtful risk than the good-conditioned man who leads an active life and who has had a genuine attack of articular gout. Oxaluria, like glycosuria, is often the herald of gout; but this warning note is often unheeded in Life Assurance examinations.

It is possible that not only the tendency to gout is inherited, but also a disposition to lead that mode of life which is conducive to it. At mid-age men who are leading less active lives than formerly do not usually modify their diet: they suffer probably from what is termed "bilious dyspepsia," or, in other words, the liver is not so active, and less oxygen is inspired. The same mistakes in the mode of life as age advances are probably made by the offspring under similar circumstances, with the result that, instead of blaming their own unhygienic mode of life, they blame solely their ancestors.

I have heard it used as an argument for the theory of the hereditary transmissson of gout that it is found more in England than in Scotland, because more Englishmen have gouty ancestors. I doubt, however, if it is not better explained by the fact that malt liquors are more drunk in England with a more highly nitrogenous diet, while in Scotland more spirits are consumed and the diet is less nitrogenous.

I have drawn attention to the first two items of my scheme of

examination, and have endeavoured to show that, in my opinion, about equal importance should be attached to the information obtained from them.

It is my intention, on a future occasion, to deal with the third head,—the physical condition as ascertained by careful medical examination—to which, as you will observe, I have attached the greatest value of all.

The fourth head, as I explained at the outset, is to be ranked as of equal value with the first two. If you asked me to value a life, and limited me to information obtainable under one of the heads only, I would select the fourth. The best guess could be made from a glimpse of the proposer.

The fourth may be linked with the fifth, the personal appearance being modified so much by the surroundings and mode of life. In fact, under personal appearance might be described any indications of irregular habits or of unhealthy occupation, including signs of sedentary habits, confinement, anxiety and worry, which are becoming more and more marked features in the description of the modern city man.

In estimating the value of a life, therefore, by inquiries under these five heads, we may be able to compare very different cases with each other. Unfavourable facts recorded under one of the heads only may be in one case counterbalanced by especially favourable information recorded under the others. A proposer who loses, say, 5 or 10 per cent. of marks under the first head may excel his fellows so much in the others as to make up for the loss, and be passed at ordinary rates. A proposer who loses, say, 5 per cent. under each of the heads is surely not to be ranked as a first-class life.

The unfavourable record under any one of the heads may be of such vital importance as to make the life ineligible. This would apply especially to the third head, where active disease was discovered by the examiner; but, in my opinion, an under-average physique and an appearance of delicacy should sometimes warrant rejection or a substantial extra, even although the personal and family records are without flaw. When the Medical Officer acts upon this idea he has usually a bad time of it with those who are responsible for the business. He is confronted by that perfect family history and that spotless personal record; and it is suggested that his own personal condition has made him see the proposer from an adverse point of view. Under such circumstances I must say that I fully sympathise with those excellent "fishers of men." Still I am more and more impressed with the fact that it is cases such as these which form early claims. I have heard it stated, and my own experience seems to prove, that a great proportion of the comparatively early deaths occur among those who have been passed at ordinary rates.

It is not my intention to enter into my statistics. I would like, however, merely to refer to one interesting lesson which they teach. Out of 800 cases examined by me for one office, of which eighty-five were accepted at an additional rate, fifty-five declined and seventeen deferred, there have been eighteen deaths during fifteen years. Fifteen of these eighteen deaths,—that is, 83⅓ per cent., were accepted at ordinary rates, and three only (15⅔ per cent.) were accepted at additions of from five to fourteen years.

I may mention as a curious fact that four out of the fifteen accepted at ordinary rates committed suicide, two of them ten years after insurance, the other two within a year.

Including several cases of acute disease, such as pneumonia and typhoid, the majority of the remaining fifteen deaths among those who were passed at ordinary rates had some facts recorded against them connected with personal appearance and general physique.

The lesson to me is to have the courage to load or refuse a life if I have a doubt, even though suggested by the personal appearance alone, about the resisting power of the individual. Before a kindred society in Dublin I hope to deal in some detail with the last three heads of my scheme of examination, and to discuss the important and difficult subject of syphilis in its bearing on Life Assurance, which of itself would form almost a sufficient subject for an address.

In conclusion, Gentlemen, permit me to express the hope that, notwithstanding some recent innovations on the part of a few Offices, the day is far distant when the Actuary and the Physician shall cease to co-operate in the great and beneficent work of Life Assurance. Might not both professions be even more closely associated than at present in a constant endeavour to increase by every available means our statistical knowledge?

I have already trespassed too much this evening upon your patience, and shall not further weary you by attempting to give shape to some ideas on the subject which have occurred to me. I have often thought that the information which is recorded in the medical reports should not only serve to guide the Office in the selection of its risks, but should yield an accumulation of facts which in the hands of the statist of the future may prove of the greatest value in placing the system of selection on the level of a more exact science.

Though I have pointed out dangers and difficulties in the selection of lives, I have also tried to indicate that often in Life Assurance

> "Our doubts are traitors,
> And make us lose the good we oft might win
> By fearing to attempt."

Some Medical Aspects of Life Assurance.[1]

MR. PRESIDENT AND GENTLEMEN,—I deemed it a high honour to receive from the Insurance Institute of Ireland an invitation to deliver an address on Some Medical Aspects of Life Assurance; and, in accepting it, I cherished the hope of being able to throw even a little light on a subject beset with many difficulties.

My remarks will be a continuation of those embodied in a paper read before the Society of Actuaries in Edinburgh. I am well aware that in dealing with this matter of the selection of lives, it may appear that I am striving after a high ideal which it is impossible to reach. We must, however, have some standard with which to compare the lives which actually come before our notice; otherwise it would be impossible to express the relative value of individual lives.

I fully appreciate the difficulty of finding a life which even approximates to that which we should take as a standard. It is only too easy to find some flaw in every proposer for assurance, and the medical officer must have that courage in forming his rapid judgments which will enable him to avoid an excess of caution that would often prove detrimental to the interest of the Company.

I have not the confidence displayed by Dr. Jobling, the medical officer of the Anglo-Bengalee Disinterested Loan and Life Insurance Company, described by Dickens in *Martin Chuzzlewit*, who not only examined but found the proposers for insurance. He was evidently more fully aware of the real secret of medical examination than we are to-day, as evidenced by his statement to the directors:—

"We know a few secrets of Nature in our profession, Sirs; of course we do. We study for that; we pass the Hall and College for that; and we take our station in Society by that. It is extraordinary how little is known on these subjects generally."

Gentlemen, I differ from Dr. Jobling, as nowadays we realise how few of the secrets of Nature we do know, and I think it is appalling how much to-day "is known on these subjects generally,"

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[1] Read before the Insurance Institute of Ireland on February 26th, 1897.

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but especially by proposers, and by Actuaries and Secretaries of Life Assurance Companies.

Jobling was of opinion, too, when refreshment for the board-room was announced, that this was "the true Life Assurance—the best Policy in the world, my dear Sir; we should be provident, and eat and drink whenever we can." One part at least of the last aphorism may, I think, be accepted as wise by the officials of Life Assurance Companies.

The subject which I have taken upon myself to expound is one that deals mainly with hard dry facts, and partly with speculative opinions, while sometimes it even borders on the fairyland of philosophy. I must content myself with modest statements of some facts (and opinions founded upon them) which have come within my own personal experience or have been recorded by others.

In my former paper I discussed at some length the reasons for giving the family history and the personal history equal values, combating the opinions of Dr. Rabagliati and others, who consider that disease is very little hereditary, and that the family history is of little importance as compared with the personal history.

I likewise indicated the great importance I attach to the personal appearance of the proposer, as judged of course by the examining medical officer.[1]

There is, perhaps, not much need to insist on the importance of the third head—the physical condition as ascertained by careful medical examination; and, as you will observe, I have attached to it the greatest value of all. It would be impossible in a paper such as this to deal at any length with the question of the diagnosis of a man's condition from the physical signs disclosed by examination; and I take it for granted that any adverse fact of this description—and the interpretation of it—noted by the medical examiner should be regarded as of the greatest value.

In the *British Medical Journal* of February 13th, a short reference was made to my statement that too great attention to the minutiæ of the medical examination for Life Assurance might lead to the general appearance of the proposer being less carefully observed than in former days. I was happy to note, that this point had not been overlooked.

This notice in the *British Medical Journal* referred to a remark of Dr. Goodhart's, that he "would pass many a heart which is now looked at askance, provided the applicant could produce evidence that he made a good breakfast." This may be a striking way of stating that much of the information which would guide us in estimating the value of a life is really beyond our reach, and that the importance to be attached to any abnormal condition disclosed

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[1] See Table at page 113 for Scheme of Examination.

by the physical examination has to be estimated by consideration of many other circumstances. I think, however, that Dr. Goodhart's suggestion might be taken advantage of by incorporating in the question regarding the amount of alcohol consumed by the proposer some inquiries as to the character of his diet.

The same note states that "from the records of one of our large Insurance Offices it has been found that the lives taken before a medical examination was instituted compared very favourably with those who were subjected to a medical examination." This comment appears to indicate that I intended to attach little importance to the medical examination, whereas in my paper I was careful to insist on the absolute importance of this, as it was the medical examiner alone who could judge of the value to be attached to the items of information supplied. The statistics of the Company referred to could, I think, be proved to be fallacious. Such statistics, based on limited numbers, are of course not of much value as compared with those of to-day, insurance having become in the meantime so much more popular and universal. I feel confident, judging from my own experience, that if we could trace even a small percentage of the cases rejected by the medical officers, we would find that the Companies had been saved from serious loss.

It is easy to point to individual cases in which rejection by a Life Insurance Company has been followed by long life. The very rejection may have been one of the elements which determined that careful life which conduces to longevity. It is difficult to say whether the creaking door will be carefully handled, though it is easy to predict that, if gently used, it may hang for years. I have been guilty of refusing a proposer for Life Assurance, and of telling him in the next breath that he might live to eighty if he pursued a certain mode of life. I could not assure the directors that he would certainly lead that perfect life which would probably make his infirmity a god-send to him. It was my duty to give the Company the benefit of the doubt.

I shall refer only very shortly to the physical examination, because to do so at any length or with any thoroughness would involve the writing of a treatise on physical diagnosis, which is not the object of a lecture before an Insurance Society.

The medical officers are well aware of the difficulties. Peculiarities in the physical signs detected by auscultation of the heart in practically healthy people—to take one example—has led to the conclusion that such peculiarities are not to be considered as always indicating grave or even slight structural changes in the organ. Temporary peculiarities in the sounds of the heart are known to exist when the blood, from various causes, is in a poor condition, although the valves are not organically at fault. The

importance to be attached to these is not often to be determined by one examination, or without taking into consideration all the circumstances which might lead to their production. Few physicians, I believe, would give to a private patient an adverse opinion as to his prospects of life, if the only physical sign noted was the presence of a heart murmur. They would try to satisfy themselves that there was no evidence of embarrassment of the action of the heart in connection with it, and to find out if no other condition indirectly connected with the heart might not account for the physical sign. If, for example, in association with the murmur, it was discovered that the patient suffered from anæmia (or poverty of the blood), or had lately been confined in ill-ventilated rooms, or had just recovered from some specific fever, the physician would take a more favourable view of the origin of the physical sign and express a hope of ultimate recovery; whereas if, in association with it, he discovered hypertrophy of the heart, displacement of the apex-beat, or peculiarities in the pulse, he would be right in giving a guarded opinion.

I have known instances of proposers who, ten to fifteen years previously, were postponed or refused on account of a cardiac murmur, the cause of which the examining physician was unable definitely to determine, but who, after the lapse of years, have been accepted at some small additional premium by the same examiner, and by others, because the sequence of events had proved that the murmur was either merely functional in origin, or, in any case, was not due to a structural disease which caused embarrassment to the organ. The difficulties of giving an opinion as to the exact cause of some of these murmurs is so great that the only choice of the medical officer is to postpone.

If the physician detects a murmur which, in his opinion, is without doubt due to structural disease of the valves, he need not of necessity reject the life. If the structural alteration in the valve can be traced to an acute malady, such as rheumatic fever or typhoid fever some years before, sometimes it need not be considered of so much importance as when no such acute illness has been recorded by the proposer. A murmur resulting from degeneration, without any history of acute disease, is much more significant. Sir William Broadbent has pointed out, in the Hunterian Lectures of 1891, that valvular lesions due to acute disease are often stationary, whereas those due to degeneration are progressive.

The subject of glycosuria in connection with Life Assurance is one which has certainly puzzled me, because I have occasionally, before examining the urine, made up my mind that the life under consideration was one for acceptance at ordinary rates, and been compelled to alter my opinion by the detection of sugar. It has

been my habit to postpone these cases for a time, and not infrequently I have found that at the next examination the sugar has practically disappeared.

It has to be kept in mind, however, in cases such as these that "doctoring" can do a great deal, and even without medicinal and dietetic treatment the imbibition of a considerable amount of fluid may not only reduce the specific gravity of the urine but render the detection of sugar impossible.

It is well known that glycosuria is often intermittent. Cases occur in Life Assurance in which, although sugar is suspected, none has been found and the urine is of extremely low specific gravity, a condition which I always regard with misgiving. Happily, in some of these instances, a rapid pulse and a suspicion of alcoholism has suggested the advisability of re-examination of the urine, when sugar has been detected. I must confess that I am at a loss to know what to do with these cases of intermittent glycosuria; but I am inclined to class them, in many instances, along with cases of oxaluria and with cases in which there is a history of gout or of frequent attacks of what the proposer calls "biliousness."

The genuine diabetic is not difficult to recognise, and I think it is not uncommon to find that a man who has been made aware of the temporary presence of sugar in his urine has become more careful of his health, and therefore enhanced his chances of longevity. Still I would hesitate to accept a proposer whose urine had shown the presence of sugar without several analyses, and without endeavouring, in some measure, to gauge the disposition and habits of the man.

There is one additional point elicited in the physical examination of the patient to which I am anxious briefly to draw attention, and that is the measurement of the chest. It is not altogether the size of the chest which is significant; rather is it the capacity for expansion which is important. I have seen large chests in which the expansile power was defective, and small chests in which the difference between the measurement during expiration and that during inspiration was as much as four inches.

It has to be remembered that a superabundance of muscular and fatty tissues may account for several inches in the chest circumference of a person who may be unable to inflate his lungs as thoroughly as one whose chest appears to be under the average of capacity. It would be well, therefore, if, in the medical report forms, all Companies adopted the plan of having the circumference of the chest during both expiration and inspiration recorded.

I have often been struck with the difficulty which some people have of understanding what it is to take a deep breath. In my capacity as Honorary Physician to the Royal Academy of Music I

have found that those who were undergoing a professional training in singing, although some were what might be termed small-chested, have been able to inflate their lungs more easily and thoroughly than those who were not undergoing such training. This appears to me to show that training in the art of breathing might, with highly beneficial results, be more widely cultivated among the community at large than it is at present.

I do not propose to cite further instances of important signs discovered by the physical examination; but in the remarks I am about to make concerning the other two items of the scheme, I must incidentally refer to others.

You will observe that in my scheme the percentage of value given to environment is less than that given to any of the other items. This is partly because I consider that it is to be linked in great measure with the personal appearance. How are we to judge of the environment of a proposer for Life Assurance? It is not only by the statement of the proposer himself, nor by the additional statements of his private friends and of the agent who introduces him, nor even by all these combined. It is, in great measure, by the opinion formed of him by the medical officer examining.

The value I have attached to the item of environment may seem inadequate; but I have given it this small value, not because I think it of less importance than the others, but because it is more difficult to obtain information of a trustworthy nature with regard to it than with regard to them. We obtain very little direct or indirect information about the proposer's habits, occupation, or associates. If we could get more exact information about these and be able better to judge of a man's temperament, I feel that the percentage of value given to this item of environment should be increased. It is only because of the difficulty of estimating these elements in judging of the environment that I value it as I have in my scheme. The environment modifies our opinions on the significance of many symptoms. A man of fine fibre, of high intellectual attainments though of defective physique, placed in circumstances suitable for the exercise of his faculties and with a determination to live and succeed, is likely to reach the expectancy of life in spite of the insurance doctor's opinion. Place the same man in unfavourable surroundings—financial embarrassments, family trouble, temptations resulting therefrom, perhaps exposure to tubercular infection—and he will serve as an example of the doctor's wisdom.

I am not quite sure that the environment for the time being of a proposer is a sure guide to us in estimating his liability, for example, to an infectious disease such as consumption. In my own experience in private practice I have been astonished to find *that some* people who have come from districts to which we would

naturally send phthisical cases, have developed phthisis in London. For example, I know of cases in which healthy people who have come from Australia and the Cape have, after a residence in this country, returned to their own, suffering from undoubted signs of tuberculosis. It may be, of course, that the ancestors of these people migrated because they were threatened with tubercular disease; but I have been unable in those cases present to my mind to obtain any such history.

Dr. James, in his interesting and able remarks after my previous paper, referred to instances which had come under his own observation of apparently fine specimens of humanity, who had come from healthy districts in Australia and the Cape to study medicine in Edinburgh, who excelled in all athletic exercises, and who fell victims to consumption. This reference was intended to combat the importance I have attached to the personal appearance of a proposer: but I think that the personal appearance—although it may, in a few cases, in some measure lead to a fallacious judgment—is undoubtedly a valuable guide. Dr. James's criticism makes me ask the question which I previously ventured to put in another way: Is a liability to tubercular infection as universally transmitted from ancestors as we imagine; and is it possible that the total absence of a tubercular family history may sometimes convey a proclivity to such infection?

It is a curious fact that cases of acute tuberculosis, not uncommonly occur among children who have only recently been brought to London from healthy country districts, and had no history of consumption in their family. May it be that these children had from their healthy surroundings and healthy ancestry, acquired no immunity against this infection, and, in virtue of these previous healthy surroundings and healthy ancestors, their tissues served as a suitable soil for the development of these bacilli? The change of environment, therefore, of these children, or of the Australian and Cape patients I have referred to, or of the colonial students cited by Dr. James, from one in which the tubercle bacilli were scarce, to one in which their presence is almost universal, perhaps made some of these otherwise healthy subjects the more readily fall victims to an organism to which they and their ancestors had been previously unused. Children in London districts, where poverty, underfeeding, and the presence of tubercle bacilli are almost constant factors, often resist the inroads of these bacilli, while the healthy immigrants from other parts, unused to this infection, sometimes fall victims, perhaps, because they have acquired no immunity.

I cannot help thinking—though it is a bold statement to make—that further investigation into the natural history of tubercle bacilli may prove that sometimes, though perhaps rarely, an

acquired immunity to this disease may be transmitted from parent to offspring, just as an immunity to certain other infectious diseases seems to be transmitted in some races, as in the cases, for example, of ague and yellow-fever. I do not deny that proclivity to infection by tubercle bacilli is more often transmitted, but not necessarily from the existence of tuberculosis or any other single disease in the parents; nor do I deny that tubercle bacilli can be directly inherited, or transmitted to the child in utero. Is it improved treatment alone, or in part some degree of inherited immunity, which is making Phthisis a less formidable disease? There is certainly more care taken nowadays to prevent infection, but this does not account for the many milder types of the disease which we see to-day. Is it too much to hope that by isolation, improved treatment, and inherited immunity, Phthisis may eventually be extinguished like leprosy, once widely prevalent in Scotland?

I think it is recognised that we can judge to some extent of a man's temperament. Is a man's temperament altogether born in him, or is it not in some measure due to his environment? His surroundings, the incidents in his life, surely alter his character, just as his physical condition changes by the influence of external circumstances. I grant that it depends to a great extent upon the individual whether the environment affects him or not: but still it is exceptional to find a man rise superior to his unfavourable surroundings.

I wish it to be understood that in coming to any conclusion with regard to the scant information supplied about the environment of the proposer, and the frequently vague ideas of his constitution gained by observation of his personal appearance, the other items of the scheme have to be constantly kept in view. The physical examination, for example, may disclose peculiarities which assume great significance in one case, and are passed over as of slight import in others. I have referred already to the occasionally great significance of the low specific gravity of the urine; and I wish now to draw attention to another point, discovered in the physical examination, which is of frequent occurrence, and the importance of which is determined by a consideration of the personal appearance and the environment of the individual.

In the experience of all medical officers for life assurance, cases frequently occur in which the pulse is of more than average rapidity. We have, in giving our recommendation to the Directors, to consider whether this is due to some temporary nervous influence—the result of excitement during the ordeal of examination, for instance—or whether it is a more or less permanent condition, indicating the possible onset of changes in the

minute arteries in consequence of alcoholic or other poisoning —which condition naturally often leads to over-action of the heart.

The judgment of the significance of this symptom is one of the most difficult with which the medical officer of an Insurance Company has to deal. The patient's statement with regard to his habits has to be taken with great caution. I have often found that the man of sober habits gives a worse account of himself in this respect than the man who is given to habitual alcoholic excess. There is a type of proposer who, having something to conceal with regard to his personal history, affects an anxiety to disclose the minutest details; and the same individual, in answer to questions concerning his habits and surroundings, will endeavour to appear abnormally straightforward. He is to be carefully distinguished from the man who is really conscientious. Answers have been given by men, whom I knew to be especially careful in their habits, which on paper would appear to the Directors as a description of irregular habits; while others have described themselves as "almost abstainers" who were well known to be addicted to habitual alcoholic excess. The description of their environment as given by these proposers is absolutely fallacious—to use no stronger term; and the medical officer who inspects the individual can alone judge of the importance to be attached to the statement.

I have frequently found it my duty to record adverse facts, such as those above noted, of symptoms observed by myself, or statements made by the proposer, and have, in certain instances, from a general survey of the case, come to the conclusion that they were of small importance, and have therefore recommended for acceptance at ordinary rates individuals whose record on paper has appeared in some respects unsatisfactory. The medical officers who examine the papers without inspecting the proposer, must of necessity attach more importance to any such adverse facts recorded, regarding symptoms or habits.

The importance to be attached to many another symptom, such as asthma and glycosuria, has to be determined practically by the appearance and the environment of the individual; and unless the examining officer makes careful notes of these, I fail to see how any opinion he may arrive at can be confirmed by the chief medical officer.

What is termed the temperament of an individual, as disclosed by his appearance and manner, has to be considered in relation to his environment, whether the former be partly due to the latter or not. A temperament of a certain type which would be especially unsuitable for certain surroundings might be the very one to conduce to longevity in other surroundings. For example,

the type of man who is unable in the small affairs of life to come to a quick and certain conclusion, is surely unsuited for occupations which entail rapid judgment, such, for example, as business on the Stock Exchange or in Mincing Lane. Men are sometimes called to fill positions in life for which they are little suited: ambition or a sense of duty draws them where they would least wish to go. The sense or knowledge of comparative failure will be more acute in the man of high intellectual attainments, and the consequences to his life would be the more grave. In private practice, we are constantly made aware by the statements of the patient of conditions of this kind. He is only too willing to guide his medical adviser in judging of the course to be pursued. The proposer for life assurance, on the contrary, under similar circumstances, though well aware that his life is endangered by the exercise of his calling, does not feel bound to give more information about the effects his environment has upon him, than can be elicited by the questions asked by the medical officer. It is often difficult to judge as to whether the temperament considered in connection with the occupation of an individual is conducive to health or the reverse, but sometimes an idea can be formed. Instances will doubtless recur to the minds of all of you in which the lives of personal friends and acquaintances have flickered out, while others, with less fine physical and mental endowments, whose "hearts were dry as summer's dust," have burned to the socket.

The term "diathesis" has been used, to my mind, somewhat vaguely. Mr. Jonathan Hutchinson says: "What we mean by diathesis is little other than an exceedingly chronic disease. It is a disease or taint which lasts a lifetime, which may be active at times and latent at times, and which may be handed on to another generation." I am unable to agree altogether with Mr. Hutchinson's definition. I would be rather inclined to say that an apparent diathesis is a condition in which the tissues and gross features of the body have stamped upon them evidences of a tendency to degeneration in a special line—a tendency which may never be actually declared. Unfavourable surroundings, however, —an acute specific disease, mental shock, overwork, might all determine the beginnings of such degeneration; but, previous to this, the structural elements of the body were in a normal condition anatomically and physiologically.

We cannot often judge, in the few minutes devoted to examination for life assurance, of a man's diathesis, which can be gauged only by observation of a complex group of characteristics. Temperament—which, I take it, is a mental characteristic—is one of the most obvious of these.

I cannot resist quoting a few lines from Matthew Arnold's

Empedocles on Etna, which seem to me shortly to sum up the relationship between heredity, diathesis and environment:—

> "Born into life we are; and life must be our mould.
>
> . . . . . .
>
> "Born into life, man grows
> Forth from his parents' stem,
> And blends their bloods as those
> Of theirs are blent in them;
> So each new man strikes root into a far fore-time.
>
> "Born into life,—we bring
> A bias with us here,
> And, when here, each new thing
> Affects us we come near;
> To tunes, we did not call, our being must keep chime."

From the heights of Matthew Arnold's poetry I have to descend to the prosaic plain of Syphilis. I select this subject because it is a constitutional disease of no infrequent occurrence among proposers for life assurance, and because it serves as an example of how, in estimating the importance to be attached to this disease, we have to take into account the information supplied under all the five heads of examination.

This is not only a most important, it is also a difficult subject in its bearing on life assurance, and in itself is almost sufficient for an address; but I have only time on the present occasion to touch the fringe of it.

I have been astonished to hear from Managers, Secretaries, and Actuaries of several Insurance Companies that the question of a personal history of syphilis so rarely comes under their notice. This is to be explained, not by the rarity of the disease, but by the fact that the question seldom appears as a direct one in many of the medical forms, and, perhaps also, as I indicate later on, by the lack of truth in the proposer's answer.

I have, for some years, held more or less definite views as to the manner in which syphilitics should be dealt with by Life Assurance Companies, and have acted according to these views in my recommendations to the Companies in any particular case.

It has been my habit to regard a history of syphilis according to the view I took of the actual state of health of the proposer himself, of his family history, of the other facts in his personal history, and of his general surroundings. There can be no regular rule of treatment, from the insurance point of view, meted out to proposers who have suffered from this malady. I have often thought that, under certain circumstances, it has proved almost an advantage to some individuals to have had syphilis. I have lived long enough to know instances in which infection with syphilis has changed the whole mode of life of

persons who otherwise might have succumbed to other and more insidious maladies consequent upon their mode of life.

I do not mean to insinuate that infection by syphilis is always an indication of an evil mode of life; but, of course, it is probable that in many instances there has been at least some temporary enfeeblement of the moral faculties from various causes.

Before dealing with the question of the effects which this disease has on the prospects of health, I would like to ask:—Do proposers always state in answer to a direct question as to infection of this nature that they have suffered from it? I am sure they do not. I believe we take many syphilitics at ordinary rates and do not know it. The honest man who says he has been so infected in early youth, or even in recent years, therefore often suffers by having to pay an extra premium; while the less honest man—and probably less intelligent man—who has attached little importance to the malady, is accepted at ordinary rates. The companies by loading every life with a history of syphilis encourage dishonesty and injure themselves as well; for were it known that they dealt leniently with this flaw in personal history, under certain conditions, proposers would not show such reluctance to own to it.

Ricord has said that "syphilis recognised is half cured," and I am inclined to agree with him, for there is no disease which medical men are more hopeful of curing, and for the cure of which they get more credit, than syphilis.

A certain percentage of men suffering from mild attacks of syphilis, seeing little or no symptoms after three months, consider that they are cured or have not had the disease; they cease treatment in consequence, and occasionally suffer later on from severe symptoms of so-called tertiary syphilis. Such cases are more dangerous, from the life assurance point of view, than those in which there have been well-marked early symptoms, which are more likely to be efficiently treated if mentioned to the medical officer of an Insurance Company.

It has to be remembered also that there are many men, who, having had severe manifestations, think nothing of disguising the fact, as there is little likelihood of their claims being repudiated on this account, because of the difficulty of proving that they died of the disease or had contracted it before insurance. In death certificates it is rare to find a record of syphilitic disease, and for obvious reasons. It is doubtful, also, if all the deaths attributed to syphilis should be traced to this disease. It has been the custom in the treatment of vague symptoms, with a doubtful history of syphilis, to obey the dictum of whist—when in doubt play trumps—and give mercury or iodide of potash. But without a post-mortem examination it is unlikely that any doctor would,

with certainty, state that the arterial degeneration and the resulting apoplexy or aneurism were due to a malady from which the patient suffered thirty or forty years before, and incorporate his suspicion in the death certificate. Arterial degeneration occurs also in those who have not had syphilis, and it seems to me unreasonable to trace it to the specific malady so often, without post-mortem proof, in those who have suffered from that disease in early youth. Early recognition and efficient treatment are likely in many instances to remove the disease from the category of serious maladies.

In the *Annales de Dermatologie et de Syphiligraphie*, of January 1897, Dr. G. Étienne, of Nancy, has an interesting paper on aneurism in its relations with syphilis. He considers that we tend more and more to admit the importance of this factor in the production of aneurism. He cites Lancereaux, who accepted it as a factor when it was a question of aneurism of the cerebral arteries, but denied it for the others; and Professor Fournier, who declared that "syphilis must assuredly take a place in the etiology of aneurism, but in what proportion of cases has still to be determined"; and Kirmisson, who affirmed that "we must not regard spontaneous aneurism as an accidental dilatation of the large vessels, but rather as the symptomatic expression of alterations of the arterial system of which alcoholism and syphilis are the principal factors."

Dr. Étienne, in his 240 cases of aneurism found indication of syphilis in 69 per cent.; but in looking over his tables, I find that in a small proportion of these there was either no treatment at all, or inefficient treatment, and, that in many, great amelioration took place after specific treatment. Among other etiological factors he finds that alcholism, malaria, articular rheumatism, and gout are the most important.

Aneurisms among syphilitics, Dr. Étienne finds, are more common in the quinquennial periods between the fifth and tenth years after infection, the fifteenth and twentieth years, and the twentieth and twenty-fifth. He thinks that we may class a good number of these aneurismal lesions in the category of diseases to which Fournier has given the name of "parasyphilis."

Of course it will be understood that Dr. Étienne's paper deals with statistics of cases of aneurism, a percentage of which had previously suffered from syphilis: its object was not to determine the number of cases of syphilitics in which aneurism was developed. This, in my opinion, would prove to be very small, and in most of them it would, I think, be found that there were other causes operating in the production of that pathological condition, such as, for example, all those conditions which are associated with a high blood-pressure.

It is true that there are occasionally late manifestations of syphilis; but they are not so common as is often supposed. It has recently been shown by statistics that nearly one half of all the nervous affections met with in syphilis appear during the first two years. These affections have been usually regarded as tertiary manifestations; whereas they are as likely to occur during the so-called secondary period.

It is, after all, a matter of peculiarity in the constitution of the individual, whether the secondary signs show themselves most markedly on the skin, on the mucous surfaces, or in the central nervous system. Surely, therefore, the lapse of time—generally two years—which is usually regarded as the period during which secondary symptoms may occur, should be considered as the limit for all acute manifestations. The true tertiary phenomena are comparatively rare, and several Continental writers have shown by their statistics that as much as from 60 to 75 per cent. of these cases had either not been previously treated at all or had been inefficiently treated. Haslund of Copenhagen believes that alcohol, excesses and malaria, are important co-operatives in the production of tertiary symptoms. Dr. Mauriac of Paris states that the number of persons who suffered from tertiary manifestations, varied from five to fifteen per cent., among all syphilitics.

Dr. George Ogilvie, in a pamphlet on "The Time of Onset of Syphilitic Disease of the Nervous System," sums up by saying: "Should we learn to discriminate between syphilitic nervous disease and non-syphilitic nervous disease in syphilitic subjects, the frequency of tertiary affections of the nervous system will shrink considerably, and the fact will stand out clearer still that nervous disease is an early manifestation of syphilis."

Mr. Jonathan Hutchinson has said: "I do not think that an Insurance Company would do a bad business if it were to undertake, at ordinary rates, young men in the early stage of syphilis. Judging from my own experience, they appear quite as likely to live as long as others, and the effect of treatment seems to be, in not a few instances, to improve the health rather than otherwise." He adds later on: "The number of those whose lives have really been shortened by syphilitic maladies has been, so far as my own personal experience goes, extremely small." This is the statement of one of the greatest syphilographers of the day, and one who has had a prolonged experience in the study and treatment of the disease.

What, then, are we to do with our proposers for life assurance who have recently suffered from syphilis? Are we to refuse them, or postpone them for a number of years, or load them with an extra premium for life? I say it depends entirely on the individual proposing, which course is to be pursued. I would

certainly refuse some who showed degeneration of any kind, although no active symptom of syphilis was present: I would refuse, or postpone, some who had recently suffered from malaria or gout, or who showed any suspicion of alcoholism: I would postpone others who, although in otherwise good health, showed some signs of the active disease; and I would accept others, with a temporary addition of, say five or seven years, who, having a good family history and an otherwise good personal record, had been under careful treatment for a year or more, and had shown no signs of their malady for many months, and who, from their appearance, gave the impression that they were likely to become careful-living men: but I think it would be unjust to make all these latter individuals pay an extra for life.

Surely, after efficient treatment lasting two years off and on, and an interval of an additional year without treatment or symptoms, the examining doctor might as honestly accept such a proposer for insurance, even at ordinary rates, as permit him to marry. I may mention that the permission to marry is given under such circumstances by the majority of medical men who have made a special study of the disease. I have on several occasions, in recent cases of syphilis, suggested an extra premium for a certain number of years, to be removed in the event of the proposer bringing evidence to show that, in the meantime, he had shown no symptoms of the disease.

Gentlemen, I have only attempted to give you an outline of some of the ideas which have occurred to me during a considerable experience of life assurance examinations. The preparation of these papers has increased my consciousness of the fact that I am unable to do more than indicate the lines which research should take, and has stimulated me to endeavour, by keeping as exact records as possible, to add my future experience—of however little value—to that of other and more able workers.

CLASSIFICATION OF INSURANCE LIVES WITH ILLUSTRATIVE TYPES.

		Ai	A	A	B	B	B	C	C	C	D	D	D	D	D
PERSONAL HISTORY	20%	+	+	−	−	+	++	−	+	+	=	+	+	++	++
FAMILY HISTORY	20%	+	−	++	−	+	−	−	+	++	++	++	+	≡	++
PHYSICAL EXAMINATION	30%	+	+	+	+	=	+	+	−	−	=	≡	+	+	+
PERSONAL APPEARANCE	20%	+	++	+	++	+	−	+	−	=	+	+	+	+	≡
ENVIRONMENT	10%	+	+	+	+	++	+	+	+	+	+	+	≡	++	+
		(ORDINARY RATES)			(SMALL EXTRA PREMIUM)			(SUBSTANTIAL EXTRA PREMIUM)			(NOT ELIGIBLE)				

EXPLANATORY NOTE OF TABLE.

The *plus* and *minus* signs indicate the value attached to the information recorded under each head in any individual case.

The *plus* sign indicates that this information is averagely favourable.

The *double plus* that it is above the average.

The *minus* that it is below the average.

The *double minus* that it is considerably below the average.

The *treble minus* that the record is extremely bad.

In *Class A* 1 nothing less than a plus is recorded under each head.

In *Class A* a minus under one head is counterbalanced by a double plus under another head.

In *Class B* there is one minus not counterbalanced.

In *Class C* there are two minus records not counterbalanced.

In *Class D* there are three minus signs not counterbalanced, or there is a treble minus under one head.

INDEXED

On Extra Risk

With some Particulars of the recent Investigation of the Mortality of Persons engaged in the Sale of Intoxicating Liquors

BY

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On Extra Risk: with some Particulars of the recent Investigation of the Mortality of Persons engaged in the Sale of Intoxicating Liquors.

THE lives which present themselves for assurance are, in the process of selection, divided into three main groups or classes :—

I. Lives insurable at the ordinary rate.
II. Lives insurable only at extra rates.
III. Uninsurable lives.

Although, in measuring what we call "extra risk," only the subdivisions of Class II. are of practical significance, yet each of the three classes admits of almost indefinite subdivision in respect of the quality of the lives embraced in it.

In the first class, some lives present no flaw of any kind in health, physical condition, occupation, or family history; others, at the further end of the scale, present flaws which bring them close to the border line of Class II.; and between those two extremes there is every degree of variation. Using terms that are not unfamiliar, Class I. may be subdivided into three distinct groups:—

(*a*) Unexceptionable lives, presenting no unfavourable feature.
(*b*) Good average lives, in which the personal or family history, or the physical condition, is not entirely faultless, but which present no feature likely to tell against the life-prospects.
(*c*) Fair average lives, presenting some flaw or imperfection, or some combination of unfavourable circumstances, which only falls short of requiring an extra premium.

The typical life—probably by far the largest of those sub-groups—is the "good average." The ordinary rate of premium may be regarded as adjusted to this kind of risk, the other sub-groups conforming approximately to the same standard. The "unexceptionable" life is not so much superior that he deserves an abatement of the usual premium, nor is the "fair average" life so much inferior as to require a higher rate. It is indeed probable that if separate mortality tables were formed from those three sub-groups, there would be sensible degrees of difference in the rates deduced from them; but in practice those differences are ignored, and it

is held sufficient to charge an average rate for the entire class. It must always be borne in mind, however, that if a favourable mortality experience is to be hoped for, the admission of doubtful lives as "fair average," instead of relegating them to Class II., must be carefully guarded.

In the second class, some lives are close to the border line of Class I., others approximate Class III., and here again there are many intermediate degrees of variation.

Even in Class III. itself there are degrees. Some lives are so hopelessly impaired that no reasonable doubt can arise as to their being uninsurable, while others are placed in this class upon a mere balance of considerations, and sometimes with the hope that they may eventually become eligible for Class II. or even for Class I.

I have thought it worth while to make those very elementary observations in order to point attention to a fact with which we are all familiar, viz.: that between the limits of "unexceptionable" and "uninsurable" there are no broadly marked lines of variation—that, on the contrary, lives vary in quality by imperceptible degrees, and that when we speak of "extra" risk as distinguished from "ordinary" or "average" risk, we make what, after all, is an arbitrary distinction.

When a risk is lower in the scale than "fair average," but is not uninsurable—when the deviation from "good average" is too great to be neglected, and the life falls into Class II.—it is obvious that the extra rate must be the entire difference between the rate for a "good average" life and that required to meet the actual risk. It must thus sometimes happen that lives presenting comparatively little difference in quality are subjected to material differences of treatment in the matter of rating. A life high up in the second class may differ but slightly in quality from a life that is just fit to be included as "fair average" in Class I., and yet may be charged a substantially higher premium. This is unavoidable in a system of classification sufficiently broad for practical use, and, after all, such a difference as that indicated is unimportant when compared with the difference made between a life that is regarded as insurable at a high extra premium and one that is regarded as not insurable at all.

But for certain practical considerations, it would not be necessary for rating purposes to subdivide Class II. any more than Class I. Regarding as one group all lives that are not insurable at the ordinary rate of premium, but are not wholly uninsurable, it would be possible to frame a scale of premiums applicable to them as a whole. Lives of this class, however, vary within much wider limits as to quality than do those of Class I. If for no other

reason than this wider variation, it would be necessary to subdivide such risks in order to treat with even approximate fairness cases which differ so much from each other. Besides, the proportion of lives presenting different degrees of impairment would always be an uncertain quantity, and while an average rate would attract the lower grades of second-class risks, those presenting lesser degrees of impairment would be unwilling to contribute a rate materially higher than their own circumstances called for. While in Class I., therefore, the lives are for rating purposes graded according to age only—the characteristic upon which the whole science of life contingencies may be said to be built up—there is of necessity in Class II. another subdivision according to the kind and degree of extra risk involved.

The classifying of lives according to their quality—referring individual cases to their place in the scale which ranges from unexceptionable to uninsurable—requires the exercise of considerable skill and experience, but after all is, and probably to a large extent always will be, dependent upon individual judgment. Given a number of cases for consideration, presenting the customary variation in the quality of the lives, it is safe to say that no two skilled persons or sets of persons would classify them alike. Probably every one accustomed to deal with proposals for assurance has a standard of his own which he applies to their consideration, and has his own views as to the importance or otherwise of particular blots in health, physical condition, or family history. Those views not only vary among different persons, but they probably also vary in the same mind at different times, and in fact they ought to vary with the growth of medical and statistical information. Especially of statistical information, for it will not be disputed that what we need above all things for the classifying and rating of lives —and what we greatly lack at present—is information of this nature. Before we can fix intelligently the rate of premium required to insure a life that presents some deviation from the normal standard of eligibility, we obviously require to know, with as near an approach to accuracy as possible, what proportion of persons of the same age, and presenting a similar characteristic, will die from year to year, just as we require to know the proportion of healthy persons dying from age to age, in order to fix a normal standard of rates.

A great deal has come to us from very competent hands on the subject of extra risks and the theory of extra premiums, and the different methods of imposing them. In comparison, however, with the magnitude of the subject, but little has been done towards

ascertaining the actual extent and measure of even the more common deviations from the normal standard. We have indeed had some valuable contributions to the measurement of the extra risk arising from climate and occupation. We have only to refer to the Index of the *Journal of the Institute of Actuaries* to find a list of papers on these subjects by actuaries whose names carry great weight and authority, and the *Proceedings* of our own Society contain various papers on different branches of this class of subjects. There has been, however, very little of a statistical nature bearing on the risk attaching to the insurance of lives presenting in their family histories traces of what, in the old-fashioned phrase, may be called "hereditary disease," or presenting in themselves even the most ordinary deviations from the normal standard of health. We have had various works on medical selection in which views are propounded on these subjects, and one work of that nature must be specially mentioned as being the joint production of a physician and an actuary, both of great skill and experience in their respective spheres—I refer to the well-known handbook of Dr. Pollock and Mr. Chisholm; but there has been but little attempt to treat the subject from the statistical point of view, in such a manner as to be of definite practical use to the actuary.

Mr. Manly, in a paper published in Volume xxx. of the *Journal*, has given an admirable illustration of the true method of solving these problems, viz.: by getting together a sufficient number of cases, tabulating them, and tracing the rate of mortality from age to age. Mr. Manly's paper is entitled "An attempt to measure the extra risk arising from a consumptive family history, when the life proposed for insurance is physically sound and healthy." The paper was based on an examination of the cases in a particular Office, where there had been any history of consumption or allied diseases in the families of the persons insured. The particulars of the risks were taken out on cards in the usual way, but with the details of the family history noted upon them. The cases were grouped according as the disease had appeared in the lineals or collaterals, or lineals and collaterals; the main groups were subdivided into classes according to the relationship of the affected persons to the assured, and mortality tables were formed for the different classes. By this means Mr. Manly arrived at various interesting and valuable results as to the extra risk arising from this particular class of defects in family history, and his "attempt" at solving a most important problem failed of complete and convincing success only because of the paucity of the data that were at his disposal.

The development of the germ theory of disease has given a fresh impetus to research and speculation on the subject of heredity, and various conflicting views have been put forward. We have heard, for instance, a good deal about the non-heredity of Phthisis, and the impossibility of its direct transmission from parent to child, and some have been inclined to dispute the importance of family history in this respect as bearing on the life-prospects of the individual. A still newer theory not only assumes the heredity of the disease, but asserts its direct transmission and the latency of the germ until circumstances favour its development. Whether one theory or the other be true, or whether they are both at fault, we, as actuaries, are not called upon to decide, and, in fact, we are scarcely concerned to know. The question for us is whether in point of fact the offspring of consumptive parents show a higher rate of mortality than the offspring of non-consumptives, and whether the difference is so great as to produce an appreciable effect on the cost of insurance. That question being determined, it may be interesting indeed to know why the difference exists—what is transmitted from the parent, whether actual disease, or a constitutional tendency to disease, or a set of tissues peculiarly susceptible to its attacks—but the inquiry is not of real practical importance to us. What would be of the greatest service in the business of life-assurance would be an inquiry of the kind illustrated in Mr. Manly's paper, but conducted on a basis sufficiently wide to give thoroughly reliable data, and embracing not one branch of inquiry only, but all those groups and classes of cases presenting extra risk which most ordinarily occur in practice. It seems highly probable that the results would modify various current views and theories — would show that in the general practice of Offices some points receive too great importance, and would bring into prominence others that at present are too much overlooked. However that might be, there can be no doubt as to the value that would attach to reliable statistics showing even approximately for different classes of under-average risks, what extra rate of mortality is really involved. There is plenty of material in the Offices for such an inquiry. It has frequently been suggested, and, although as yet the idea has not advanced beyond the stage of suggestion, it may be hoped that some day the Offices will awaken to its importance, and that the inquiry will be undertaken on a sufficiently wide and comprehensive basis. It will be a work of great labour, and it will call for the joint exercise of medical and actuarial skill — the medical to group appropriately the various special features in personal and family

history to be dealt with, and to refer individual cases to their proper groups, and the actuarial to tabulate the results and bring them into a form suitable for practical use.

It was with some such view of practical utility, but in a branch of inquiry not calling for the aid of medical skill, that the Managers of the Associated Scottish Life Offices undertook some years ago an investigation into the mortality of assured persons who were engaged in the sale of intoxicating liquors. The Reports of the Committee entrusted with the investigation have been printed and circulated,[1] and the general results have become pretty widely known.

The second Report shows that among eighteen different groups of persons, either engaged directly in the sale of intoxicating liquor, or presumably or possibly connected with that branch of trade—thirteen of the groups consisting of males and five of females—only five had a smaller percentage of deaths than the Hm Table would have indicated. Of these, four were unimportant in number, viz.: Wine Merchants in England (who were probably Wholesale Dealers), Travellers in the Liquor Trade, Female Publicans, and Female Grocers. The remaining group was that of "Grocers" in Scotland, where there was no indication whether or not the persons were licensed to sell liquor. As another fairly numerous group, consisting of "Licensed Grocers," showed a distinct extra rate of mortality, it is fair to hold that the business of selling liquor by retail, even when it is to be consumed off the premises, involves exposure to an extra risk of death.

The remaining groups, thirteen in number, showed annual extra rates of mortality varying from about ·1 to about 20 per 1000 exposed to risk. Some of the groups were small, and some were not very well defined. The Committee did not seek to build any important conclusions upon these, but the following groups stood out as presenting very decided features, and embracing in each case a fair number of years of risk:—

	No. of Lives.	Exposed to Risk.	Average duration of Risk.	Died.		Annual Mortality per cent.		
				Actual.	Expected.	Actual.	Expected.	Difference.
Publicans, ...	1,761	15,009	8·5	430	235·37	2·86	1·56	1·30
Innkeepers, ...	941	10,757	11·4	306	198·44	2·84	1·84	1·00
Hotel-keepers, ...	979	8,038	8·2	204	125·34	2·54	1·56	·98
Licensed Grocers, Ireland, .	255	2,019	7·9	46	29·13	2·28	1·44	·84
Licensed Grocers, Scotland,	713	5,915	8·3	102	74·93	1·72	1·26	·46

[1] They are reprinted in full in the *Journal of the Institute of Actuaries*, vol. xxxiii. pp. 245-261.

In comparison with the three large groups of Publicans, Innkeepers, and Hotel-keepers, the Licensed Grocers in Ireland and in Scotland, though sufficiently numerous to prove the existence of extra mortality, were scarcely numerous enough to furnish material for separate detailed investigation. It will be noticed that the additional death-rate differs in the two countries, being larger in Ireland than in Scotland. This is no doubt due to the fact alluded to in the Committee's Report, that whereas in Ireland the Licensed Grocer has a bar at which drinking may and does take place, the Licensed Grocer in Scotland is only permitted to sell for consumption off the premises. Beyond noting this difference, and suggesting rates of premium which correspondingly vary for the two classes, the Committee have not attempted to pursue an analysis of the statistics relating to Licensed Grocers; and it is not proposed in this paper to carry the investigation further in this respect than the Committee have done.

For reasons stated in their Report—chiefly because of a difficulty in finding any clear line of distinction—the Committee thought it advisable to amalgamate the two groups of Hotel-keepers and Innkeepers. Their principal deductions, therefore, have reference to two main classes—(1) Publicans, and (2) Innkeepers and Hotel-keepers.

The Committee, at the outset, proposed to themselves various subjects of investigation, which unfortunately it proved impossible to pursue, on account of the necessary material not being forthcoming. It would have been very useful, for instance, to know, how far any extra rate of mortality is affected, (*a*) by the age at which a person enters upon the occupation of retailing liquor, and (*b*) by the length of time he has been in the trade. The records of the Offices, however, do not give the needful information. A person proposing for insurance is described as a Publican, an Hotel-keeper, or an Innkeeper, and his age is stated, but as a rule no inquiry is made as to how long he has been in the trade. At all events the Offices were not able to supply this information.

Again, it would have been very desirable to know when a life included in the observations ceased to be connected with the liquor trade. There is no doubt that many persons leave this class of occupations to follow other pursuits, or to live on their accumulated gains. It was thought that the practice of remitting in these circumstances the extra premium usually charged for occupation might afford the means of eliminating such cases from the statistics, but only in very few instances were the Offices able to state on the cards supplied to them when an extra premium had been taken

off. It was therefore found necessary to abandon this line of inquiry also.

Accordingly it must be carefully borne in mind, as qualifying any apparent decrease in the extra rate of mortality as age or duration of risk increases, that the statistics include all persons returned by the Offices as having insured under the above-mentioned designations, whether they continued their connection with the liquor trade or not. This is perhaps an important qualification; but the precise measure of its importance we have not the means of determining. It emphasises, however, the recommendation of the Committee, that before an extra rate is remitted in consequence of the Assured having given up the sale of liquor, evidence should be obtained both as to health and habits; and it suggests this consideration, that when remission is granted in such cases, those who remain liable to extra premium will probably be subject to a higher rate of mortality than the Committee's tables indicate.

The above qualification also suggests caution in assuming that the diminished extra rates of mortality shown by the statistics after long duration of Assurance are necessarily applicable in the case of persons who, after a similar lapse of time, continue actively engaged in the liquor trade. The statistics do indeed seem to support the view commonly held, that the extra risk grows less as men become habituated to the adverse influences and temptations of the business. They by no means furnish an accurate measure of the diminution, still less do they prove that lives may become entirely free from extra risk after long-continued exposure to those influences and temptations.

The Committee show that among 1761 Publicans, exposed to 15,009 years of risk, the expected number of deaths by the Hm Table was 235·37, while the actual number was 430. Also it will be seen from the Report, that out of 1920 Hotel-keepers and Innkeepers, exposed to 18,790 years of risk, the expected number of deaths was 323·78, while the actual number was 510.

Taking as a measure of the extra risk the proportion which the excess of the actual over the expected deaths bears to the "exposed to risk," we have the following percentages:—

Publicans, . . . $\frac{430-235}{150{\cdot}09}=1{\cdot}30$

Hotel-keepers and Innkeepers, $\frac{510-324}{187{\cdot}90}=0{\cdot}99$

This is the method that has been commonly pursued in finding extra rates for occupation, when these have been based on investigations similar to the one now under consideration. It was the

method adopted, for example, by Mr. Stott, in a paper in Vol. xx. of the *Journal*, giving the mortality experience of the Scottish Amicable Society among "Innkeepers, Publicans, and other persons engaged in the sale of intoxicating liquors," during 50 years ending 1876. The statistics gave 3529 years of "exposed risk," and 102 deaths among Publicans and Innkeepers, as compared with the following numbers of "expected" deaths, viz. :—

62·480 by the Carlisle Table.
60·847 by the Hm Table.
68·524 by the English Life Table, No. 2 (Males).

Applying the figures deduced from the English Life Table, Mr. Stott brought out an extra rate of mortality of ·948 per cent., which he regarded as indicating an extra premium of 19s. nett. A similar comparison with the Hm Table would give as the extra rate of mortality $\frac{102-61}{35{\cdot}29}=1{\cdot}16$. Combining the above figures from the collective experience as reported by the Committee, we have as the extra rate for Publicans, Hotel-keepers, and Innkeepers, $\frac{940-559}{337{\cdot}99}=1{\cdot}13$, a result that is strikingly corroborative of Mr. Stott's earlier investigation.

An interesting feature of Mr. Stott's paper was a Nosological Table, showing the causes of death in comparison with those which prevailed among the general body of lives insured with the Scottish Amicable Society, and among the population at large as given by the Registrar-General. Following the classification adopted by the Registrar-General for England, the table shows what percentage of the total deaths was caused by each group of diseases. The following is an abbreviation of the table, with the headings slightly altered for greater clearness :—

	Percentage of total Deaths.		
	Publicans.	Assured Lives generally.	Population.
1. Zymotic Diseases,	8·8	19·4	16·0
2. Diseases of uncertain seat (including Cancer),	4·9	3·9	3·8
3. Tubercular Disease,	15·7	13·8	25·2
4. Diseases of Nervous System,	21·6	16·8	9·8
5. Heart Disease,	12·7	8·7	7·1
6. Bronchitis,	9·8	10·1	11·3
7. Diseases of Digestive Organs,	20·6	12·5	8·8
8. Disease of Kidney,	2·9	3·0	3·0
9. Other causes (including Old Age),	3·0	11·8	15·0
	100·0	100·0	100·0

A comparison made in this form is apt to be misleading, and from the tenor of some comments made by Mr. Stott on the figures, it would appear as if that gentleman had himself been misled. He speaks of the mortality from Diseases of the Nervous System, the Organs of Circulation, and the Digestive Organs, as being "about 30 per cent., 50 per cent., and 60 per cent. respectively in excess of the general mortality experience of the Society itself"; of the mortality from Tubercular Disease and Bronchitis as being "40 per cent. and 13 per cent. respectively under the expectation"; and of the deaths by Contagious and Infectious Diseases, as being "45 per cent. below the ordinary death-rate, and 55 below the Society's general experience." What the figures really show is, that in an equal number of deaths among the Publicans, the general body of Assured lives, and the population respectively, the proportions due to the various classes of diseases differed by the percentages stated. In order to compare correctly the mortality from different diseases among the Publicans and among (say) the general body of Assured lives, it is necessary to increase the figures in the above Table, applicable to the Publicans, in the proportion by which the total deaths in that class exceeded the deaths among a corresponding number of their fellow-policyholders. Mr. Stott shows that the deaths among Publicans were just 50 per cent. in excess of those among Non-Publicans assured in the Society. Increasing the "Publicans" column of the above Table by 50 per cent., we get the following table of comparison:—

	Deaths.	Proportion of Deaths.	
		Publicans.	Non-Publicans.
1. Zymotic Diseases,	9	13·2	19·4
2. Diseases of uncertain seat,	5	7·4	3·9
3. Tubercular Disease,	16	23·5	13·8
4. Diseases of Nervous System,	22	32·4	16·8
5. Heart Disease,	13	19·1	8·7
6. Bronchitis,	10	14·7	10·1
7. Diseases of Digestive Organs,	21	30·9	12·5
8. Disease of Kidney,	3	4·4	3·0
9. Other causes,	3	4·4	11·8
	102	150·0	100·0

In this table the actual number of deaths has been inserted in order to show that we must not draw very wide conclusions from such limited data; but the lessons to be drawn from the figures,

so far as they go, seem to differ materially from those deduced by Mr. Stott. We learn from this table that among Publicans the deaths due to Diseases of the Nervous System, Heart Disease, and Diseases of the Digestive Organs, were respectively 93 per cent., 120 per cent., and 147 per cent. in excess of the number of deaths from corresponding causes among Non-Publicans assured in the same Office—that in place of the deaths from Tubercular Disease and Bronchitis being "under the expectation," they were respectively 70 per cent. and 45 per cent. above the proportions among Non-Publicans—and that the mortality from Zymotic diseases was only 32 per cent. and not 55 per cent. below the Society's general experience. Generally speaking, the mortality from organic and constitutional diseases was much higher among the Publicans than among the Non-Publicans. It was exceptionally high in those classes which include diseases commonly induced by the abuse of stimulants, and it was also high in Tubercular Disease and Bronchitis, owing no doubt to the unhealthiness of the Publicans' daily atmosphere.

Ten years ago Mr. Wallace favoured the Society with a paper "On the Rate of Mortality among Liquor Sellers," embodying the results of an investigation he had made of the experience of the North British and Mercantile Company in this class of risks. The paper contains much valuable detailed information. Combining the figures given by Mr. Wallace for Hotel-keepers and Publicans (under which latter designation he includes Innkeepers, etc.), and again comparing the actual deaths with the "expected" by the Hm Table, we get the following extra rate, viz.: $\frac{153-97}{47{\cdot}61}=1{\cdot}17$, which is all but identical with Mr. Stott's 1·16 and with the 1·13 per cent. deduced from the new collective experience. Mr. Wallace, however, gives separately the figures relating to (1) Licensed Grocers, (2) Hotel-keepers, and (3) Publicans, Innkeepers, etc. Comparing his results with those of the collective experience, the following are the extra rates of mortality, viz.:—

	North British and Mercantile.	Scotch Offices.
Licensed Grocers, . . .	·34	·46
Hotel-keepers, . . .	·86	·98
Publicans and Innkeepers, .	1·24	1·17

Mr. Wallace's "Licensed Grocers" included a large proportion of persons who seem to have been described simply as "Grocers." I am inclined to think that some of these may not have been licensed, and that this may account for the more favourable experience of his Office as indicated above. In the collective investigation it was found that "Grocers" had no extra rate of mortality.

In the Session following the production of Mr. Wallace's paper, the Society were favoured with a similar paper by Mr. Douglas, based on the experience of the Life Association of Scotland. Mr. Douglas adopted a different grouping from Mr. Wallace, dividing his liquor sellers into two classes—(1) "Innkeepers," in which he included Innkeepers, Hotel-keepers, Waiters, and such like; and (2) "Publicans," in which he included Publicans, Retail Wine and Spirit Merchants (apart from Grocers), Licensed Victuallers, Barmen, etc. Practically, his class of "Innkeepers" corresponds to the combined class of "Innkeepers and Hotel-keepers" in the collective experience, and his "Publicans" and the Publicans of that experience correspond. Mr. Douglas, like Mr. Stott and Mr. Wallace, and like the Committee who conducted the collective investigation, worked out the expected deaths by the Hm Table, so that we are enabled to make the same comparison as before. Combining the two classes above mentioned, we get as the extra rate of mortality for the whole liquor sellers included in Mr. Douglas's investigation, $\frac{215-143}{84\cdot56} = \cdot85$. There is thus a somewhat remarkable difference between the experience of the Life Association of Scotland and the other experiences above mentioned. This is not to be accounted for by the lives having been a shorter time under observation, for the average duration of risk in all the sets of observations is much the same. When Mr. Douglas's figures are compared in more detail with those of the collective experience, the peculiarity is still observable:—

	Extra Mortality per cent.	
	Life Association.	Scotch Offices.
Publicans, ...	·98	1·30
Innkeepers and Hotel-keepers,	·73	·99
Publicans, Innkeepers, and Hotel-keepers, . . .	·85	1·13

Mr. Douglas points out a striking difference in his tables between the extra mortality of Publicans in England and in the other parts of the kingdom. The extra rate for England is only 0·46, while that for Scotland and Ireland together is 1·34, almost identical with that for the whole Publican lives included in the collective experience. Here evidently lies the chief disparity between the results and those of other observers; but the reason of such a marked divergence from ordinary experience, unless it arise from mere paucity of data, is difficult to apprehend. In the collective experience the extra rate of mortality among English Publicans was fully as high as that among Publicans in Scotland and Ireland.

Besides the three Offices already mentioned, the "Standard," through Mr. Thomson (see his address to this Society on 1st November 1877), and the Law Life Office, have given the benefit of their experience to the profession. The Standard Company's experience of the whole class of liquor sellers (Innkeepers, Publicans, etc.) shows an extra rate of ·90 above the Hm Table, and the experience of the Law Life in this class of risks shows an extra rate of 1·19 above their own general experience.

From all these investigations it may be held as fully established (1) that there is extra mortality among persons engaged in the sale of intoxicating liquors by retail; and (2) that among those who sell liquor for consumption on the premises, the extra mortality exceeds on the average 1 per cent. per annum.

The object of the recent collective investigation was to determine the rates of extra premium that should be charged. It was not, of course, pretended by any of those who conducted the various investigations above referred to, that by taking the ratio between the number of deaths in excess of the "expectation" and the number of lives exposed, we have a thoroughly scientific method of arriving at the extra premium for an occupation risk. When statistics are scanty, this method gives an excellent rough-and-ready means of fixing a rate, and it has the advantage of generally erring on the safe side, provided the extra risk is fairly constant, or at all events is not so distributed as to make an average rate insufficient at an early stage. The Committee have shown in their Report that the extra rates deduced by this method exceed at all periods of life the difference between the ordinary premium rates of the Hm Table and the rates calculated from tables of mortality based on this particular experience. They have stated in general terms the reason of this excess, viz.: that a true extra premium would be calculated not on the whole

amount assured, but on the difference between that and the policy-value. It may be interesting to examine this point more closely.

Putting q'_x for the actual rate of mortality or probability of dying in a year when an extra rate is involved, we have for the extra rate of mortality

$$q'_x - q_x = \Delta q_x,$$

and the extra premium to insure 1 for that year is $v\Delta q_x$. And as $p_x + q_x$ and $p'_x + q'_x$ must each $= 1$, we have $p_x - p'_x = \Delta q_x$.

Now, whatever be the basis of a valuation made when a yearly premium is just due and unpaid, the valuation reserve and the premium together (the *net* premium if the valuation is by the net premium method) must be sufficient to cover the risk of the next ensuing year, and to provide the necessary reserve at the end of that year if the policy is then in existence. Putting π'_x for the entire net premium where extra risk is involved, and therefore $\Delta\pi_x$ for the extra premium, we have

$$_nV_x + \pi'_x = vq'_{x+n} + vp'_{x+n}(_{n+1}V_x)$$

and

$$_nV_x + \pi_x = vq_{x+n} + vp_{x+n}(_{n+1}V_x)$$

whence, by deduction,

$$\Delta\pi_x = \Delta q_{x+n} \times v(1 - {}_{n+1}V_x).$$

That is to say, the extra premium is equal to the extra rate of mortality for the year multiplied by the difference (discounted at interest) between the amount assured and the policy-value at the end of the year.

It is here assumed that notwithstanding the existence of extra risk, the policy-value will be the same as if the life were an average one. In other words, it is assumed that each year's extra premium will be put against that year's risk. This is the ordinary method of dealing with extra premiums imposed on account of occupation, and such extra premiums are also commonly imposed in the form of a constant percentage of the sum assured. If, however, the premiums and policy-values are alike calculated by a special mortality table, the expression for $\Delta\pi_x$ becomes somewhat more complicated. We have then

$$_nV'_x + \pi'_x = vq'_{x+n} + vp'_{x+n}(_{n+1}V'_x)$$

whence

$$\pi'_x = vq'_{x+n} + vp'_{x+n}(_{n+1}V'_x) - {}_nV'_x.$$

Similarly

$$\pi_x = vq_{x+n} + vp_{x+n}(_{n+1}V_x) - {}_nV_x$$

whence

$$\Delta\pi_x = \Delta q_{x+n}\{v(1 - {}_{n+1}V'_x)\} + vp_{x+n}\Delta(_{n+1}V_x) - \Delta(_nV_x).$$

$\Delta(V)$ being in each case the difference between the policy-values

according to the tables from which π'_x and π_x are respectively calculated.

Extra risk may be compensated in other ways besides the two above mentioned, as, for instance, by the familiar method of an addition to the age at which the rate of premium is calculated. Also, the valuation of extra-rated policies may be made in various ways. Such policies may be valued at the true age and on the same basis as policies issued at the ordinary rate of premium—they may be valued at an increased age corresponding to the higher rate of premium charged—or they may be valued by the special table which reflects the mortality of the class of risks to which they belong. The method of valuation does not necessarily follow from the method of fixing the extra premium. An extra premium may be fixed as a constant percentage of the sum assured, and yet the case may be treated for valuation purposes as if effected at an age corresponding to the actual premium charged. Or an addition may be made to the age for the purpose of fixing the extra premium, and yet the case may be dealt with on the basis of setting each year's extra premium against that year's extra risk, and reserving only the ordinary policy-value. Or, on the principles indicated by Mr. Meikle in his well-known paper on "Policy Life-Lines," the premium may be calculated from a special mortality table, and the valuation be made by the table in ordinary use; and so on through the various combinations of methods of rating and valuing. Any of those combinations may be suitable in given circumstances and unsuitable in others. The really important point to be borne in mind is that the method of valuation has as much to do with the appropriateness of a given premium as the actual rate itself. Thus we may fix a rate entirely suitable, according to a table of mortality corresponding to the risk, but if we mean to value by another table whose annuity values diminish less rapidly from age to age, we shall ultimately be left with an inadequate provision for the risk. We shall, in fact, treat as profit a part of the necessary provision for the liability under the policy. On the other hand, if we value by a table whose annuity values diminish more rapidly than those of the table from which the premium is calculated, we shall have an inadequate provision for current risk, but we shall be making too large a provision for future risk and carrying forward for that purpose what really belongs to the profit fund if the current risk has been otherwise met. All this may be deduced from the well-known formula ${}_nV_x = 1 - \frac{a_{x+n}}{a_x}$.

It may be said that these considerations apply to the method of

valuation and not to the method of fixing the premium; that what they teach is that the nature and amount of the extra premium and the true measure of the extra risk must be taken into account in calculating the reserve or policy-value, rather than that the premium must be adjusted with reference to the valuation. It is not, however, practicable to have a separate valuation for each class of extra risks, and we must be content to adjust our rates of premium and our valuations to each other as well as circumstances will admit. Although, as above stated, policies carrying extra risk may be rated and valued in a variety of ways, there are certain combinations of method which have been sanctioned by custom. We shall consider some of these, and see the varying character of the deviations from the normal rate of mortality which they provide for.

1. When an addition is made to the age in fixing the rate of premium, it is usual to treat the policy for valuation purposes as if effected at the increased age corresponding to the rate of premium charged. In this case

$$\pi'_x = \pi_{x+n}$$
$$\Delta\pi_x = \pi_{x+n} - \pi'_x$$
$$\text{and} \quad {}_nV'_x = {}_nV_{x+n}.$$

The extra rate of mortality provided for in the first year is obviously $q_{x+n} - q_x$; in the second year, $q_{x+n+1} - q_{x+1}$; and in the $(m+1)^{\text{th}}$ year, $q_{x+m+n} - q_{x+m}$. It will be found that this extra rate of mortality in the main increases with the duration of the policy, but increases with more or less irregularity according to the smoothness with which the mortality table is graduated. Taking, for example, a life of 25 rated up 5 years, the following are the extra rates of mortality per cent., or in other words, the successive values of $100(q_{30} - q_{25})$, $100(q_{31} - q_{26})$, etc., by the Hm and the Carlisle Tables respectively:—

	Hm Table.	Carlisle Table.		Hm Table.	Carlisle Table.
1st year	·109	·279	14th year	·135	·342
2nd ,,	·123	·284	15th ,,	·147	·292
3rd ,,	·120	·236	.....	...	...
4th ,,	·111	·135	.....	...	...
5th ,,	·107	·033	31st ,,	·865	1·557
.....	...	...	32nd ,,	·959	1·679
.....	...	...	33rd ,,	1·065	1·651
11th ,,	·153	·275	34th ,,	1·186	1·404
12th ,,	·138	·322	35th ,,	1·287	1·150
13th ,,	·127	·352			

It will be noticed that the progression, although irregular in both Tables, is on the whole steadier in the case of the Hm. A still more smoothly graduated table would give a steadier progression of values of $q_{x+n}-q_x$.

The above extra rates of mortality correspond to a uniform annual extra premium of ·2545 per cent. by the Hm, and of ·2490 by the Carlisle Table at 3 per cent. interest.

2. When (as usual in the case of climate and occupation risks) a percentage extra rate is charged, it is customary to value the policy at the real age and set each year's premium against that year's risk. In this case

$$\pi'_x=\pi_x+\frac{1}{y}$$

$$\Delta\pi_x=\frac{1}{y}$$

$$\text{and}\quad {}_nV'_x={}_nV_x.$$

The progression of $(q'_{x+n}-q_{x+n})$ is here essentially different and less dependent for its smoothness on the even graduation of the mortality table. We have already seen that in this case

$$\Delta\pi_x=v\Delta q_{x+m}(1-{}_{m+1}V_x).$$

Giving ${}_{m+1}V_x$ its value of $1-\frac{a_{x+m+1}}{a_x}$, the above equation becomes

$$\Delta\pi_x=v\Delta q_{x+m}\frac{a_{x+m+1}}{a_x},$$

whence $$\Delta q_{x+m}=\frac{\Delta\pi_x a_x}{v a_{x+m+1}}.$$

From the nature of this expression for Δq_{x+m}, it is obvious that when there is a constant extra premium, which is treated as covering and being exhausted by each successive year's extra risk, the extra mortality allowed for depends partly on the age at entry, and is at a gradually and steadily increasing rate for successive ages attained. For the expression consists of a constant $\frac{\Delta\pi_x a_x}{v}$ and a variable $\frac{1}{a_{x+m+1}}$, the latter being of gradually and steadily increasing value. The same form of expression holds good whatever be the value of m.

When $m=0$, $\Delta q_x=\frac{\Delta\pi_x a_x}{v a_{x+1}}$, *ms,*

$$\text{when } m=n,\ \Delta q_{x+n}=\frac{\Delta\pi_x a_x}{v a_{x+n+1}},$$

whence $$\Delta q_{x+n}=\Delta q_x\,\frac{a_{x+1}}{a_{x+n+1}},$$

and generally $$\Delta q_{x+m}=\Delta q_{x+n}\,\frac{a_{x+n+1}}{a_{x+m+1}}.$$

Also $$\frac{\Delta q_{x+m}}{\Delta q_{x+n}}=\frac{a_{x+n+1}}{a_{x+m+1}}.$$

That is to say, when the extra premium is constant and values are calculated by the real ages, then for each age at entry, *the extra rates of mortality allowed for at any two ages attained are to one another in the inverse ratio of the values of annuities-due at the next higher ages.*

In contrast with the values deduced from the expression $q_{x+n+m}-q_{x+m}$, the following are the values of $100\,\Delta q_{x+m}$ by the Hm 3 per cent. Table when $x=25$, and the addition to the premium is of the same amount as $100(\pi_{30}-\pi_{25})$, viz.: ·2545, as already mentioned.

	$m=$	$\Delta q_{x+m}=$		$m=$	$\Delta q_{x+m}=$
1st year	0	·265	14th year	13	·313
2nd ,,	1	·268	15th ,,	14	·318
3rd ,,	2	·271	.....	...	...
4th ,,	3	·274	.....	...	...
5th ,,	4	·277	31st year	30	·454
.....	...	...	32nd ,,	31	·468
.....	...	...	33rd ,,	32	·482
11th year	10	·299	34th ,,	33	·498
12th ,,	11	·303	35th ,,	34	·514
13th ,,	12	·308			

From the equation $\Delta\pi_x=v\Delta q_{x+n}(1-{}_{n+1}V_x)$ it follows that when extra premium is dealt with in the manner supposed, a constant extra mortality may be met by a decreasing rate of extra premium. Putting $X_0\ X_1\ \ldots\ X_m$ for the extra premiums in the 1st, 2nd . . . $(m+1)^{\text{th}}$ years respectively, we have

$$X_0=v\Delta q(1-{}_1V_x)=v\Delta q\frac{a_{x+1}}{a_x}$$

13t. $$X_1=v\Delta q(1-{}_2V_x)=v\Delta q\frac{a_{x+2}}{a_x},\ \text{etc.},$$

whence $$X_1 = X_0 \frac{a_{x+2}}{a_{x+1}}$$

$$X_2 = X_0 \frac{a_{x+3}}{a_{x+1}}$$

$$X_m = X_0 \frac{a_{x+m+1}}{a_{x+1}}$$

$$X_n = X_0 \frac{a_{x+n+1}}{a_{x+1}},$$

whence $$X_m = X_n \frac{a_{x+m+1}}{a_{x+n+1}},$$

whence also $$\frac{X_n}{X_m} = \frac{a_{x+n+1}}{a_{x+m+1}}.$$

That is to say, when there is a constant extra rate of mortality, and values are calculated by the real age, then for each age at entry, *the extra premiums required at any two ages attained are to one another in the direct ratio of the values of annuities-due at the next higher ages.*

Assuming a constant extra mortality of 1 per cent. ($q = \cdot 01$), the extra premiums for successive ages, calculated by the Hm 3 per cent. table for age 25 at entry, would be as follows:—

Age attained.	Value of X.	Age attained.	Value of X.
25	$X_0 = \cdot 961$	38	$X_{13} = \cdot 814$
26	$X_1 = \cdot 951$	39	$X_{14} = \cdot 801$
27	$X_2 = \cdot 940$	...	.....
28	$X_3 = \cdot 930$	55	$X_{30} = \cdot 561$
29	$X_4 = \cdot 919$	56	$X_{31} = \cdot 544$
...	.....	57	$X_{32} = \cdot 524$
35	$X_{10} = \cdot 851$	58	$X_{33} = \cdot 511$
36	$X_{11} = \cdot 839$	59	$X_{34} = \cdot 495$
37	$X_{12} = \cdot 826$		

We have seen that $$\frac{\Delta q_{x+m}}{\Delta q_{x+n}} = \frac{a_{x+n+1}}{a_{x+m+1}};$$

also that $$\frac{X_n}{X_m} = \frac{a_{x+n+1}}{a_{x+m+1}}.$$

It follows that $$\frac{\Delta q_{x+m}}{\Delta q_{x+n}} = \frac{X_n}{X_m}.$$

That is, the age at entry being x, and annuity-values and policy-values being calculated as at real ages, *the decreasing extra premiums,*

at any two ages attained, that will provide for a constant extra rate of mortality, are to one another in the inverse ratio of the extra rates of mortality, at the same two ages, that would be provided for by a constant extra premium.

3. When the class involving extra risk is sufficiently large to merit separate treatment, and when accordingly the premiums and policy-values are calculated by means of a special table constructed from the observed rate of mortality. We have already seen that in this case,

$$\Delta \pi_x = v\Delta q_{x+n}(1-{}_{n+1}V'_x)+vp_{x+n}\Delta({}_{n+1}V_x)-\Delta({}_nV_x),$$

whence $$\Delta q_{x+n}=\frac{\Delta\pi_x-vp_{x+n}\Delta({}_{n+1}V_x)+\Delta({}_nV_x)}{v(1-{}_{n+1}V'_x)}.$$

Now since $$\pi'_x=\frac{1}{a'_x}-d,$$

and $$\pi_x=\frac{1}{a_x}-d$$

$$\Delta\pi_x=\frac{1}{a'_x}-\frac{1}{a_x}.$$

Substituting this value in the above equation, and expressing the values of V in terms of their corresponding annuity-values, we have

$$\Delta q_{x+n}=\left\{\frac{1}{a'_x}-\frac{1}{a_x}+vp_{x+n}\left(\frac{a'_{x+n+1}}{a'_x}-\frac{a_{x+n+1}}{a_x}\right)-\left(\frac{a'_{x+n}}{a'_x}-\frac{a_{x+n}}{a_x}\right)\right\}\div\frac{v\,a'_{x+n+1}}{a'_x}.$$

Remembering that $vp_{x+n}\,a_{x+n+1}=a_{x+n}$, we see that the terms involving a_{x+n} and a_x cancel out, and this leaves

$$\Delta q_{x+n}=p_{x+n}-\frac{a'_{x+n}}{v\,a'_{x+n+1}}.$$

The same result may be reached in a more direct way, for

$$a'_{x+n}=vp'_{x+n}\,a'_{x+n+1}$$

$$p'_{x+n}=\frac{a'_{x+n}}{va'_{x+n+1}},$$

and since $$\Delta q_{x+n}=p_{x+n}-p'_{x+n}$$

$$\Delta q_{x+n}=p_{x+n}-\frac{a'_{x+n}}{va'_{x+n+1}}.$$

Now since $$\Delta\pi_x=\frac{1}{a'_x}-\frac{1}{a_x},$$

we have $$\frac{1}{a'_x}=\frac{1}{a_x}+\Delta\pi_x$$

$$=\frac{1+\Delta\pi_x\,a_x}{a_x},$$

and
$$\mathrm{a}'_x = \frac{\mathrm{a}_x}{1+\Delta\pi_x\,\mathrm{a}_x}$$

$$a'_x = \frac{\mathrm{a}_x}{1+\Delta\pi_x\mathrm{a}_x} - 1$$

$$= \frac{a_x - \Delta\pi_x\mathrm{a}_x}{1+\Delta\pi_x\mathrm{a}_x}.$$

Substituting these values of a′ and a' in the previous equation, we have

$$\Delta q_{x+n} = p_{x+n} - \frac{a_{x+n} - \Delta\pi_{x+n}\mathrm{a}_{x+n}}{v\mathrm{a}_{x+n+1}} \cdot \frac{1+\Delta\pi_{x+n+1}\mathrm{a}_{x+n+1}}{1+\Delta\pi_{x+n}\mathrm{a}_{x+n}}.$$

This new equation furnishes the means of comparing the extra rates of mortality provided for by a given rate of extra premium, (*a*) when policy-values are calculated by the ordinary tables, and (*b*) when these are calculated by a special table corresponding to the rates of premium charged. Mr. Ryan has shown by illustration (*Journal*, vol. xxiv. p. 19) that in the latter case a uniform extra rate of premium provides for an extra rate of mortality which is nearly uniform throughout life. We have already seen that in the former case a similar extra premium provides for a steadily increasing extra rate of mortality—a rate that varies, moreover, with the age at entry as well as with the age attained. We can now see how the extra rates of mortality involved in those two methods of rating and valuing are related to each other.

When the extra rates of premium $\Delta\pi_x$, $\Delta\pi_{x+n}$, etc., are uniform, we may write the last equation

$$\Delta q_{x+n} = p_{x+n} - \frac{a_{x+n} - \Delta\pi\mathrm{a}_{x+n}}{v\mathrm{a}_{x+n+1}} \cdot \frac{1+\Delta\pi\mathrm{a}_{x+n+1}}{1+\Delta\pi\mathrm{a}_{x+n}}.$$

We shall call this extra rate of mortality $\Delta q^{(b)}_{x+n}$ to distinguish it from the corresponding rate $\Delta q^{(a)}_{x+n}$ when policy-values are calculated by the ordinary table. Putting for convenience $\frac{1}{1+\phi}$ in place of $\frac{1+\Delta\pi\mathrm{a}_{x+n+1}}{1+\Delta\pi\mathrm{a}_{x+n}}$, and noting that $\frac{a_{x+n}}{v\mathrm{a}_{x+n+1}} = p_{x+n}$, the equation becomes
$$\Delta q^{(b)}_{x+n} = \frac{1}{1+\phi}\left\{p_{x+n}(1+\phi) - p_{x+n} + \frac{p_{x+n}}{a_{x+n}}\Delta\pi\mathrm{a}_{x+n}\right\},$$

$$= \frac{p_{x+n}}{1+\phi}\left(\frac{\Delta\pi\mathrm{a}_{x+n}}{a_{x+n}} + \phi\right)$$

$$= \frac{p_{x+n}}{a_{x+n}} \times \frac{\Delta\pi\mathrm{a}_{x+n} + \phi a_{x+n}}{1+\phi}.$$

As we have before seen,

$$\Delta q^{(a)}_{x+n} = \frac{\Delta \pi a_x}{v a_{x+n+1}}$$

$$= \frac{p_{x+n}}{a_{x+n}} \times \Delta \pi a_x.$$

We thus have the means of directly comparing the extra rates of mortality provided for by a given uniform rate of extra premium, (*a*) when valuations are made by the ordinary table, and (*b*) when they are made by a table corresponding to the actual net rates of premium including extra.

$$\frac{\Delta q^{(a)}_{x+n}}{\Delta q^{(b)}_{x+n}} = \frac{\dfrac{p_{x+n}}{a_{x+n}} \times \dfrac{\Delta \pi a_{x+n} + \phi a_{x+n}}{1+\phi}}{\dfrac{p_{x+n}}{a_{x+n}} \times \Delta \pi a_x}$$

$$= \frac{\Delta \pi a_{x+n} + \phi a_{x+n}}{(1+\phi)\Delta \pi a_x}.$$

In applying some of the results thus arrived at to the mortality experience which forms the main subject of this paper, we may dismiss for practical purposes the first of the three methods of rating and valuing which we have been considering. It will not generally be thought suitable to rate up the premiums for insuring the lives of liquor sellers by making an addition to the age. In fact, it may here be incidentally remarked that the system of adding to the age for rating and valuation purposes is shown, by the character of the extra mortality for which it provides, to be unsuitable for many, perhaps most, classes of extra risks. The extra mortality, small and slowly increasing at first, becomes considerable at the period of life when extra risk is most probably at an end. If, for example, the prevailing view be well founded that an hereditary predisposition to phthisis is more likely to show itself in comparatively early manhood than after the age (say) of 35, this method is obviously most unsuitable for dealing with the case of young lives which present a consumptive family history; although, on the other hand, it may be suitable for constitutional tendencies of a different kind which become aggravated with advancing years. This, however, opens up a very wide field of inquiry which cannot be explored within the limits of the present paper.

If any Office thinks it worth while to open a separate section for Assurances on the lives of liquor sellers, suitable scales of premium may be arrived at by means of the mortality tables referred to in the Committee's Report. Those tables, with the 3 per cent. premiums and annuity-values deducted from them, are appended to this paper. From what has been said it will be

apparent that for valuation purposes the same tables should be used, or, at all events, tables giving similar policy-values.

Most Offices, however, will doubtless prefer to charge a percentage extra rate calculated on the sum assured, and to immix this class of policies with others for valuation purposes. The Committee, in their second Report, suggested a scale of extra premiums as warranted by the experience, assuming that the Offices desired to maintain this method. The rate suggested for Publicans was 25s., and for Innkeepers and Hotel-keepers 20s. per cent. per annum. Two points must be kept in view—

(1) That these are suggested as additions to the Office premium, and not as net rates.

(2) That the rate is to be calculated on the sum assured only, and in practice is not increased when Bonuses are added.

Allowing 20 per cent. for "loading," we may take the corresponding net rates as 20s. for Publicans and 16s. for Innkeepers and Hotel-keepers. For simplicity, we shall suppose that any necessary provision for Bonuses may be made out of the loading, so that the net extra rates will be applicable to the sum assured alone. It will be seen that those rates correspond fairly well with the difference between the Hm 3 per cent. net rates and the corresponding rates deduced from the Committee's special mortality tables, viz.:—

Age.	Publicans.	Innkeepers and Hotel-keepers.
20	·692	·615
25	·822	·718
30	·963	·782
35	1·077	·810
40	1·087	·798
45	1·002	·718
50	·892	·602
55	·746	·464
60	·398	·289

As we have seen how important is the relation of policy-values to the suitableness of extra premiums, it will be interesting to compare the policy-values of the three tables above mentioned. This is done in the following table for quinquennial ages at entry, and for the several durations of 5, 10, and 20 years. For comparison a fourth set of values has been added, being the policy-values calculated by Mr. Ryan, and given in his paper already referred to on the assumption that $\pi'_x = \pi_x + \cdot 01$. Values which exceed those of the Hm Table are underlined.

POLICY-VALUES AT 3 PER CENT.

$x=$	25	35	45	55
Duration 5 years. $_5V_x$.				
I. Hm,	5·31	7·20	10·23	14·19
II. Publicans,	6·89	6·17	7·59	9·82
III. Innkeepers and Hotel-keepers,	5·71	6·11	7·80	11·82
IV. Ryan ($\Delta\pi = \cdot 01$),	4·43	6·11	8·91	12·78
Duration 10 years. $_{10}V_x$.				
I.	11·12	15·28	21·09	28·07
II.	13·31	12·03	16·17	19·38
III.	11·14	12·31	16·75	24·36
IV.	9·31	13·12	18·63	25·65
Duration 20 years. $_{20}V_x$.				
I.	24·71	33·16	43·24	53·71
II.	23·74	26·25	32·42	42·86
III.	22·08	27·00	37·03	49·80
IV.	21·21	29·31	39·50	50·60

We may gather from this table that for all but the younger ages and shorter durations, the policy-values by the special mortality tables applicable to the two classes of liquor sellers are lower than those of the Hm Table. Hence we may infer, that an Office charging such lives a uniform extra rate which makes the total net premium nearly equal to that which a true table would indicate, but valuing the policies by the Hm 3 per cent. Table, will make a needlessly high reserve against future risk. As a corollary, it will follow that in such a case the Office will not make a sufficient provision out of the extra premium for the current extra risk from year to year. Accordingly, we shall find in the following table that in most cases the extra risk of mortality provided for by the net extra premiums of 20s. per cent. for Publicans and 16s. per cent. for Innkeepers and Hotel-keepers, is less than the actual extra rate of mortality. The table is constructed for ages at entry and durations similar to those in the above table of policy-values. Under column I. in each case is shown the difference between the values of $100q_{x+n}$ by the Hm Table and by the graduated experience Table—in other words, the extra rate of mortality per cent. ($100\,\Delta\,q_{x+n}$) at the age attained. In column II. are shown the values per cent. of what is called in a former part of this paper

$\Delta q^{(a)}_{x+n}$, the extra rate of mortality provided for by the extra premium, on the assumption that policy-values are calculated on the Hm 3 per cent. basis. In column III. are shown the values per cent. of $\Delta q^{(b)}_{x+n}$, the extra rate of mortality provided for on the assumption that policy-values are calculated from a hypothetical table corresponding to the net premium, viz.: $\pi_x + \cdot 01$ for Publicans and $\pi_x + \cdot 008$ for Innkeepers and Hotel-keepers. In the case of the Publicans the figures in the column are taken from a table given by Mr. Ryan in the paper already referred to. In the case of the Innkeepers and Hotel-keepers the corresponding figures have been calculated by means of the formula

$$\Delta q^{(b)}_{x+n} = \frac{p_{x+n}}{a_{x+n}} \cdot \frac{\Delta \pi a_{x+n} + \phi a_{x+n}}{1+\phi}.$$

The equivalent expression $\frac{p_{x+n}}{1+\phi}\left(\frac{\Delta \pi}{a_{x+n}} + \Delta \pi + \phi\right)$ is rather more convenient for computation. Where $\Delta q^{(a)}_{x+n}$ or $\Delta q^{(b)}_{x+n}$ exceeds Δq_{x+n}, the values in the table are underlined.

PUBLICANS.

Net extra rate to which $\Delta q^{(a)}_{x+n}$ and $\Delta q^{(b)}_{x+n}$ correspond = 1·0 per cent.

Age at Entry.	Duration (Years). 0			5			10			20		
	I. Δq_{x+n} ×100	II. $\Delta q^{(a)}_{x+n}$ ×100	III. $\Delta q^{(b)}_{x+n}$ ×100	I. Δq_{x+n} ×100	II. $\Delta q^{(a)}_{x+n}$ ×100	III. $\Delta q^{(b)}_{x+n}$ ×100	I. Δq_{x+n} ×100	II. $\Delta q^{(a)}_{x+n}$ ×100	III. $\Delta q^{(b)}_{x+n}$ ×100	I. Δq_{x+n} ×100	II. $\Delta q^{(a)}_{x+n}$ ×100	III. $\Delta q^{(b)}_{x+n}$ ×100
25	·52	1·04	1·25	·71	1·10	1·31	1·20	1·18	1·29	1·64	1·40	1·39
35	1·20	1·04	1·29	1·56	1·13	1·29	1·64	1·24	1·40	·96	1·59	1·36
45	1·64	1·05	1·40	1·48	1·17	1·39	1·57	1·34	1·36	·13	1·89	1·34
55	1·57	1·06	1·36	1·62	1·24	1·40	·96	1·49	1·34	2·49	2·33	1·30

INNKEEPERS AND HOTEL-KEEPERS.

Net extra rate to which $\Delta q^{(a)}_{x+n}$ and $\Delta q^{(b)}_{x+n}$ correspond = 0·8 per cent.

	I.	II.	III.	I.	II.	III.	I.	II.	III.	I.	II.	III.
25	·59	·83	·98	·83	·88	·99	1·02	·94	1·02	1·29	1·12	1·08
35	1·02	·84	1·02	1·18	·90	1·04	1·29	·99	1·08	1·04	1·27	1·11
45	1·29	·84	1·08	1·12	·94	1·09	1·04	1·07	1·11	·46	1·75	1·10
55	1·04	·85	1·11	·79	·99	1·12	·46	1·19	1·10	·40	1·87	1·05

It will be observed that in the majority of instances the values of $\Delta q_{x+n}^{(a)}$ are less than the corresponding values of Δq_{x+n}. That is to say, that when policy-values are calculated by the Hm Table at 3 per cent., the extra rates of mortality provided for by the uniform net extra premiums of 1·0 per cent. and 0·8 per cent. respectively, are less than the observed extra rates of mortality. The following table shows the net extra premiums that would be required to provide for the observed extra mortality when policy-values are calculated on the above basis. These rates are derived from the formula $\Delta \pi = v \Delta q_{x+m}(1 - {}_{m+1}V_x)$.

Age at Entry.	Duration (Years).			
	0	5	10	20
	PUBLICANS.			
25	·50	·65	1·02	1·18
35	1·15	1·38	1·32	·99
45	1·56	1·26	1·17	·51
55	1·48	1·31	·65	1·07
	INNKEEPERS AND HOTEL-KEEPERS.			
25	·57	·75	·87	·92
35	·98	1·05	1·04	·66
45	1·23	·95	·77	·24
55	·98	·64	·31	·19

The inference to be drawn from these tables is, not that the respective net extra rates of 20s. per cent. and 16s. per cent. are inherently insufficient to provide for the observed rates of extra mortality, but that they are insufficient both to do that and to provide the reserves that are indicated by a table giving other rates of mortality. The Office charging those extra rates and including the policies for valuation purposes among its general business, may receive an adequate consideration for the risk, and yet may misapply it by carrying more to the reserve than is necessary, and more than is really left over after covering the extra risk from year to year.

On the other hand, there is this to be borne in mind, that an Office charging the extra rates supposed, and valuing the Policies as a class by themselves, could not afford to remove the extra rate on the lives assured relinquishing the occupation of selling liquor. The reserves in hand would not be sufficient to meet future risk on the basis of the ordinary premium.

On the whole, then, we may conclude that the extra rates recommended by the Committee are by no means excessive if the ordinary methods of valuation are to be followed, and especially if the extra rate is to be remitted on the assured giving up the occupation of selling liquor, even if in that case evidence of continued good health and habits be required.

A word of warning as to the use of those rates may not be out of place. As already stated, the statistics from which the Committee's conclusions are drawn comprised all persons of the occupations named, however long they had been in the trade, and whether or not they continued in it until they passed from observation. Presumably they were all accepted as temperate persons and good lives of their class. If, therefore, in practice any Office seeks to distinguish between favourable and unfavourable cases in the matter of rating—between, say, men who have just entered the trade, and men who have been a long time engaged in it—let it be clearly understood that if the average rate is inapplicable to the one class, it is also inapplicable to the other. If some are excused from extra charge or accepted at a modified rate, the discrimination must also extend to refusing others or charging a rate higher than the common one.

Here for the present I must leave my subject. I do so with the feeling that it is by no means exhausted, either in its theoretical or its practical aspect—that, in fact, some of the problems connected with the rating and valuing of extra risks are merely indicated and by no means worked out, and that there remain very wide fields of investigation to be explored before we arrive at a full comprehension of the subject of extra risk, or a thoroughly satisfactory method of dealing with it in practice.

PUBLICANS.

Unadjusted Data.

Age (x)	Exposed to risk.	Died.	q_x	Age (x)	Exposed to risk.	Died.	q_x
20	10	...	...	54	296	10	·034
21	21	...	...	55	276	11	·040
22	30	...	...	56	259	9	·034
23	46	1	·022	57	236	12	·051
24	72	...	...	58	211	12	·056
25	111	...	...	59	189	7	·037
26	154	2	·013	60	172	12	·070
27	189	1	·005	61	147	5	·034
28	238	3	·012	62	132	6	·045
29	283	2	·007	63	116	6	·052
30	328	7	·021	64	105	3	·029
31	382	5	·013	65	93	6	·065
32	419	5	·012	66	78	5	·064
33	444	10	·023	67	64	2	·031
34	478	7	·014	68	60	3	·050
35	513	10	·019	69	51	3	·049
36	529	12	·022	70	44	3	·067
37	534	16	·030	71	38	2	·053
38	541	12	·022	72	33	...	...
39	557	12	·021	73	30	...	...
40	563	18	·032	74	28	3	·077
41	551	14	·025	75	23	3	·130
42	547	16	·029	76	19	1	·053
43	525	12	·023	77	18	4	·222
44	513	13	·025	78	14	3	·214
45	491	19	·039	79	8	1	·125
46	477	15	·031	80	6	...	...
47	453	11	·023	81	6	1	·167
48	435	12	·025	82	6	1	·167
49	407	14	·035	83	5	1	·200
50	383	12	·031	84	3	1	·333
51	354	8	·022	85	2	...	...
52	333	12	·036	86	2	...	...
53	316	11	·034	87	1	1	1·000

PUBLICANS.

Adjusted Values.

Age (x)	p_x	q_x	a_x	π_x	Age (x)	p_x	q_x	a_x	π_x
20	·9900	·0100	18·872	2·119	48	·9702	·0298	12·603	4·438
21	·9896	·0104	18·634	2·181	49	·9698	·0302	12·381	4·560
22	·9892	·0108	18·395	2·243	50	·9692	·0308	12·149	4·693
23	·9889	·0111	18·153	2·308	51	·9685	·0315	11·911	4·832
24	·9886	·0114	17·908	2·376	52	·9675	·0325	11·668	4·981
25	·9882	·0118	17·658	2·447	53	·9663	·0337	11·421	5·138
26	·9878	·0122	17·405	2·521	54	·9649	·0351	11·174	5·301
27	·9873	·0127	17·149	2·597	55	·9633	·0367	10·928	5·471
28	·9867	·0133	16·890	2·680	56	·9615	·0385	10·685	5·645
29	·9860	·0140	16·631	2·760	57	·9597	·0403	10·447	5·823
30	·9852	·0148	16·373	2·843	58	·9578	·0422	10·212	6·006
31	·9842	·0158	16·118	2·930	59	·9559	·0441	9·983	6·193
32	·9830	·0170	15·868	3·016	60	·9541	·0459	9·756	6·385
33	·9817	·0183	15·626	3·102	61	·9524	·0476	9·533	6·581
34	·9804	·0196	15·396	3·187	62	·9509	·0491	9·309	6·788
35	·9792	·0208	15·175	3·270	63	·9495	·0505	9·084	7·004
36	·9780	·0220	14·962	3·352	64	·9483	·0517	8·854	7·236
37	·9769	·0231	14·757	3·434	65	·9470	·0530	8·617	7·485
38	·9759	·0241	14·560	3·514	66	·9457	·0543	8·372	7·758
39	·9750	·0250	14·366	3·596	67	·9443	·0557	8·118	8·054
40	·9741	·0259	14·177	3·676	68	·9427	·0573	7·855	8·380
41	·9734	·0266	13·991	3·758	69	·9410	·0590	7·582	8·739
42	·9728	·0272	13·804	3·842	70	·9391	·0609	7·299	9·135
43	·9722	·0278	13·616	3·929	71	·9371	·0629	7·006	9·578
44	·9718	·0282	13·425	4·020	72	·9350	·0650	6·700	10·074
45	·9714	·0286	13·229	4·116	73	·9327	·0673	6·381	10·636
46	·9710	·0290	13·027	4·216	74	·9300	·0700	6·047	11·278
47	·9706	·0294	12·819	4·324	75	·9265	·0735	5·697	12·019

HOTEL-KEEPERS AND INNKEEPERS.

Unadjusted Data.

Age (x)	Exposed to risk.	Died.	q_x	Age (x)	Exposed to risk.	Died.	q_x
20	4	...	...	54	453	12	·027
21	10	...	...	55	428	18	·042
22	20	...	...	56	389	12	·031
23	45	...	...	57	360	10	·028
24	67	...	...	58	321	15	·047
25	98	2	·020	59	297	7	·024
26	139	2	·015	60	273	9	·031
27	186	...	...	61	254	12	·047
28	248	9	·036	62	231	10	·043
29	285	2	·007	63	205	5	·024
30	332	7	·021	64	185	10	·054
31	375	7	·019	65	164	10	·061
32	428	6	·014	66	142	13	·092
33	468	6	·013	67	121	5	·041
34	515	5	·010	68	107	10	·093
35	566	11	·019	69	91	4	·044
36	577	13	·022	70	80	9	·112
37	609	16	·026	71	69	3	·044
38	613	13	·021	72	62	6	·097
39	628	13	·021	73	47	3	·064
40	649	16	·025	74	37	2	·054
41	640	15	·023	75	32	1	·031
42	638	17	·027	76	28	1	·036
43	634	15	·024	77	26	3	·115
44	643	15	·023	78	20	2	·100
45	622	15	·024	79	13	...	...
46	606	17	·028	80	10	2	·200
47	580	19	·033	81	7	3	·429
48	544	12	·022	82	4	...	...
49	537	11	·020	83	2	1	·500
50	525	14	·027	84	1	...	...
51	513	10	·019	85	1	...	...
52	496	7	·014	86	1	...	...
53	476	16	·034	87	1	1	1·000

HOTEL-KEEPERS AND INNKEEPERS.

Adjusted Values.

Age (x)	p_x	q_x	a_x	π_x	Age (x)	p_x	q_x	a_x	π_x
20	·9906	·0094	19·187	2·042	48	·9736	·0264	13·154	4·153
21	·9900	·0100	18·950	2·100	49	·9732	·0268	12·916	4·273
22	·9894	·0106	18·716	2·159	50	·9728	·0272	12·670	4·403
23	·9888	·0112	18·484	2·220	51	·9721	·0279	12·415	4·542
24	·9882	·0118	18·254	2·281	52	·9713	·0287	12·154	4·690
25	·9875	·0125	18·026	2·343	53	·9705	·0295	11·889	4·846
26	·9868	·0132	17·802	2·406	54	·9695	·0305	11·618	5·013
27	·9861	·0139	17·582	2·469	55	·9686	·0314	11·343	5·189
28	·9854	·0146	17·365	2·532	56	·9676	·0324	11·062	5·377
29	·9847	·0153	17·151	2·597	57	·9665	·0335	10·775	5·580
30	·9840	·0160	16·940	2·662	58	·9652	·0348	10·483	5·790
31	·9834	·0166	16·732	2·727	59	·9640	·0360	10·187	6·026
32	·9828	·0172	16·525	2·793	60	·9624	·0376	9.884	6·276
33	·9822	·0178	16·318	2·862	61	·9605	·0395	9·578	6·541
34	·9816	·0184	16·112	2·931	62	·9586	·0414	9·271	6·823
35	·9810	·0190	15·907	3·003	63	·9565	·0435	8·961	7·127
36	·9804	·0196	15·702	3·074	64	·9543	·0457	8·650	7·450
37	·9798	·0202	15·496	3·150	65	·9520	·0480	8·336	7·798
38	·9792	·0208	15·290	3·226	66	·9498	·0502	8·019	8·176
39	·9786	·0214	15·083	3·305	67	·9464	·0536	7·696	8·587
40	·9779	·0221	14·875	3·387	68	·942 8	·0572	7·376	9·027
41	·9772	·0228	14·668	3·470	69	·9390	·0610	7·058	9·498
42	·9766	·0234	14·461	3·556	70	·9348	·0652	6·742	10·004
43	·9760	·0240	14·252	3·644	71	·9310	·0690	6·429	10·548
44	·9754	·0246	14·040	3·736	72	·9260	·0740	6·112	11·148
45	·9749	·0251	13·826	3·832	73	·9200	·0800	5·799	11·796
46	·9744	·0256	13·608	3·933	74	·9130	·0870	5·492	12·491
47	·9740	·0260	13·384	4·039	75	·9060	·0940	5·196	13·226

INDEXED

Forms of Life Office Books

BY

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ASSISTANT MANAGER OF THE CITY OF GLASGOW LIFE ASSURANCE COMPANY

Forms of Life Office Books.

(*Read before the Society, 8th April* 1897.)

ELEVEN years have elapsed since anything on the subject of Office Books was before you. Mr. M'Lauchlan's paper, which was read in April 1886, has long since become a classic, and has been of incalculable service as a text-book for the Faculty and Institute Examinations. All-embracing as it is, however, its great scope rendered it impossible to treat, within the limits of one paper, all aspects of Life Office Book-keeping and its kindred topic Life Office Records, so fully as may be done by taking the subjects in sections. I shall be glad, therefore, if my contribution be looked upon as a practical tribute of my sense of indebtedness to Mr. M'Lauchlan's paper, and as an attempt to expand a small portion of it. I hope my example may be the means of inducing others to do likewise.

Mr. R. P. Hardy recently said (*J.I.A.*, vol. xxxii. p. 443) that to frame a scheme of books and forms that were at once analytical and interlocking, presenting at the same time the maximum of convenience for the needs of to-day, encumbered by the mere minimum of what was indispensable for the emerging wants of the future, was in itself a liberal and highly stimulating education.

Mr. H. W. Manly, in the course of the same discussion, remarked that they were all anxious to get their books into such order that they would as it were interlock and check each other. He further indicated that it was too much to assume that their books were perfect, and he expressed a desire for a whole set of forms of books which were necessary for conducting the business of an Office.

In what follows, I have attempted to describe in detail a system the aim of which is to provide a set of books which will, with the minimum of labour, conveniently and accurately give at any moment the kind of information most frequently required in regard to a Life Policy. It is assumed that it is proper to have the information at Head-office in as accessible a form as possible in regard to every policy wherever it may be actually renewable,—whether at Head-office, at a Branch, or through an Agency.

Let us assume that the necessary preliminaries have been com-

pleted, and that the policy is ready for delivery. Having received a number, it is entered in the

Register of Life Policies Issued.

The form of this book must be so designed as to permit of clearly recording in it every essential particular of the assurance at the moment of issue, provision being made so far as is possible by special columns for commonly recurring features, confining the use of the Remarks column to noting unusual peculiarities. The more complete the record here made of the particulars, the more completely will it be possible afterwards to dispense with reference to the copy policy or the proposal papers. It is recommended that this book should be confined to the use which its name implies, that is, of providing a register of the new policies issued in any year, from which the particulars will be posted to the various books in use in the office. Its summation will give at the end of the year, or at any desired point of time, the policies issued up to that date—the net New Business being got by deducting the policies not taken up. It will be noticed that no provision is made for any writing-off in the New Policy Register itself. Everything of that kind is better done elsewhere. Similarly in regard to alterations, the entry once made remains in its original form to all time, so far as this book is concerned.

The most convenient way of entering the premiums in half-yearly and quarterly cases is to enter the half-yearly premium twice and the quarterly premium four times, the various months of renewal being also separately given. The advantage of this will be seen when the Renewal Premium Charge Books are dealt with.

We may now discuss the posting of the particulars of the policies to the other books. The order in which this is actually done is of little moment, the main point being to keep all the sections of the work well up to date. We shall begin with the

Index to Lives Assured.

Not very long ago most Offices were content with the well-known "Vowel" Index. The labour involved in its use and the time occupied are so great in comparison with the "Initial-Three-Letter" system that no doubt can possibly exist as to the desirability of having the Index in the latter form. The particulars recorded should be as few as possible, every other consideration being made subsidiary to exhibiting at a glance the numbers of the policies on any one life.[1] The fewness of the particulars recorded, in addition

[1] The Index should only contain Christian name, surname, occupation, address; Date of Birth, No. of Policy.

to giving this immense positive advantage, has the negative advantage of preventing the book being used for anything else than an Index.

There should also be provided, in a handy and portable shape, the complement of the ordinary Index, namely, a

Numerical Index of Life Policies.

It is not necessary in this book to give the name of the assured, but it should contain in the first volume the Nos. 1 to, say, 50,000 or 100,000. (These may be printed, one on each line, when the book is made.) The other columns should give "Class," "Month of Renewal and how Payable," "Agency," and a small column for "Fate." The convenience of such a book as this is very great —more especially in connection with the system of Classified Policy Registers and Renewal Premium Charge Books now to be described.

Classified Policy Registers.

Into these Registers the policies are posted from the Register of Life Policies issued,—the various classes being kept in separate sections. So far as the arrangement of these books has reference to the reception of the particulars of the policies at the time of issue, the forms explain themselves. The main features—Year of Entry, Policy No., Name of Life Assured, Date of Birth, Age at Entry, Sum Assured, Premium, How and When Payable, Agency, Remarks—are the same for all classes of policy. It will be convenient to have an additional column (say, under Remarks) for the Date of Last Payment in Limited Payment cases, and in the case of Endowment Assurances two columns, one for Last Payment of Premium and another for Date when Sum Assured is payable. In With Profit cases columns must be provided for recording the Bonuses. These should be three in number—the first for Bonuses up to last Investigation, a second for the New Bonus Declared, and a third for the Total Bonus. It is desirable that the Registers should last for more than one valuation period, and this is quite feasible if the Bonus columns be arranged as in the form given.

We shall now look at the provision made for keeping the Registers up to date. The entry of the new policies as issued is simple enough, but alterations and cancelments must also be dealt with. Alterations are of various kinds, but they can all be ranged under two main divisions, "Written off" and "Written on." Thus, if the class of a policy is altered—*e.g.* if a Whole Life Policy is converted into an Endowment Assurance, the sum assured remaining the same while the premium is increased, all that requires to be done to the Registers is to write *off* the policy

in the Whole Life Section, and write it *on* in the Endowment Assurance Section, being careful to note under Remarks the particulars of the alteration, so that for valuation and other purposes these may be kept in view. Suppose, however, that a policy is surrendered to the extent of one-half, it is only necessary to write off the one half, leaving the other half on the Books. Again, take the place of an understatement of age involving an increase of premium to rectify it. This involves the necessary alteration of date of birth and age at entry, and requires the insertion of the increase in premium in the Additions to Premium column. Ordinary cancelments, such as Surrenders, Lapses, Claims by Death or Survivance, require merely to be entered in the Written-off column. Assuming the new business to have been posted—all necessary alterations and cancelments given effect to—the business in force at the end of the year is found by summing the new business on to the previous year's total, and then adding the Additions to Premium column. From this, the total of the Written-off columns must be deducted, and the result gives the business in force at the end of the year—*i.e.* the number of policies in force, the sums assured, the bonuses, and the premiums payable. In regard to summation, it may be stated that when written up the Register is summed and balanced with its predecessor. This summation remains fixed. The summations of the Additions to Premium and Written-off columns vary from year to year. It is convenient in their case not to record each year's summation at the foot of the page, but to keep the record in a separate book or sheet prepared for the purpose. The summations of the Written-off column will of course get heavier each year, and it will therefore be a convenience when, without unduly increasing the breadth of the page, two sets of Written-off columns are provided—one being used for the first half of the book's lifetime, and the second for the remaining period. The absence of bonuses in Without Profit policies makes it unnecessary to have the Non-Profit Registers so often rewritten as the Profit ones.

The forms above described will meet the wants of most Offices, namely, those where the Bonuses take the form of reversionary additions to the sum assured. They are suitable also to the case where the Bonuses take the form of reduction of premium—the reductions being simply entered in the Written-off column. In this case, it will be advisable to have one or more sets of premium columns showing the reduction of premium at each valuation and the resulting premium after giving effect to the reduction. The forms can also be very easily made to suit the case of Discounted Bonus Policies when it is desired to show the difference between the full With Profit Premium and the premium actually payable. Three columns are required for this—one for

the full With Profit Premium, another for additions to it, and a third for writings-off. Particular cases may require special treatment, but what has been said shows the elasticity of the system and its great adaptability.

The labour involved in the periodical rewriting of the books is amply rewarded by the sense of security given when one is able to deal with records which are correct and up to date; and, moreover, by the omission in succeeding sets of the policies which went off during the life of the previous sets, the current books are freed from a mass of obsolete information.

Important as these Registers are, they are necessarily in much less constant requisition than the books to be next described—the

Renewal Premium Charge Books.

In a year when claims are heavy, an Office consoles itself with the reflection that Insurance Offices exist to pay claims. If the mental attitude of the public were in like manner tersely described, the expression might take the form that Offices exist to collect premiums. Both, of course, are half-truths, and while even in combination they are far from expressing the whole truth, yet the backbone of the life insurance system is that it collects premiums with which to pay claims. These premiums lend themselves to system to a remarkable degree. We have contracts with possible —and, in many cases, actual—durations of many years, the premiums during all that time being unchanged. There is not even the complication of a varying income-tax, not to speak of a varying rate of interest or even a varying amount of principal as in loan transactions. Broadly speaking, we have, as a groundwork, year by year the same premiums coming to the Office through precisely the same channels or Agencies. The mention of Agencies leads me to say that the Renewal Books now to be described are not only eminently suited to meet the case of an Office with a large network of Agencies,[1] but their cardinal features are derived from the fact that such Agencies exist. Take the case of a Company with a Head-office, say ten Branches, and the usual army of Agents under each. The first division of the renewals which naturally occurs, is according to the month of renewal—then a subdivision under each month according to Head-office or Branch. The sections will of course vary in size with the size of the business at each particular Office, but we have thus far divided the renewals into 132 different groups. The premiums collected by Agents in correspondence with Branches

[1] Agent will throughout the paper be used to include Branch, Head-office Agent, or Head-office Cashier.

come to Head-office through the Branch accounts, and only one division in each month is therefore kept for each Branch. Head-office too, however, has its own Agents, and the policies renewable through each Agent should be separately entered under his Agency. Having thus settled the divisions of the books, we may now discuss their form and the particulars to be entered.

The space at the top is intended for

Name of Month (at extreme left and right of page).
Name of Branch or Agency (in centre of page).

In the case of Agents the Agency should appear on the left page, and the Agent's name on the right page. It will be convenient where the renewals are few to have two or even three Agencies on one folio. Great clearness will be given to the months, etc., if these are put in with rubber types. The printed headings of the various columns speak for themselves. As the month appears at the top of the page it is only necessary to place in the first column the day of the month on which the premium falls due. The amount of the sum assured need only be given if it is to appear in the premium receipt. The column headed Commission forms no essential part of the system, but it has so many advantages that its insertion is strongly recommended. If we record here, when the other particulars are being written up, the rate of commission and to whom it is payable, we provide in the simplest and most accessible form the means of checking the commission taken from year to year. The Remarks column may be described as a sort of danger signal. Take the case of a Half Premium or Endowment Assurance Policy. In the first of these the column will contain the words "After 1896 £...," indicating that the low rate ceases in 1896, and that in 1897 the higher premium becomes payable. In the other case, the insertion of "L.P. 1896" shows that the last payment falls due in 1896, and that no charge is to be made in 1897. Temporary variations of premium—*e.g.* by application of Bonus—are also noted here. In actual working the column is very convenient. In the first place, the writer and comparer of the receipts keep their eye on the column as they go along, but in addition the column can be quickly run down to see that all the markings applying to any particular year are attended to. The small column in front of the current premium is for the insertion of ½ or ¼ so as to show whether the premium is payable half-yearly or quarterly.

The date to be inserted in the columns "Dates when premiums paid," may either be the actual date on which it is paid by the assured, or, as this is not easily got, it may be advisable to be content in all cases with the date on which the premium is accounted for to Head-office. The great point is, that a record be made that it

is accounted for, and that the source from which the marking-up was made can be readily traced if desired. This marking-up in the Head-office books of the payment of every premium is not done in all Offices, but without it the Head-office must frequently be put to it to find out quickly and certainly whether a premium is paid, which scarcely seems a satisfactory state of matters.

There follow columns—one for each year—for "Premiums Written-off or Transferred to other Agencies." "Written-off" means not only policies going finally off the books, but also the one part of the operation involved in altering a premium, viz. writing it off in full, the writing-on being also done in full whether the premium is being increased or decreased. With regard to these columns it may be mentioned that it would perhaps be more complete if there were two for each year—one for writings-off *before* and another for writings-off *after* the debit for the month has been made up. This would, however, take up too much room, and the end to be served by the first of these columns may be attained much more simply and conveniently by making up a note of the Details of Written Off since the previous 31st December. This note will contain not only the writings-off which are final and which go through the column in ink, but also suspense forfeitures and all other deductions which can be merely noted, so far as the Premium Charge-book is concerned, in the meantime in pencil, and which may or may not eventually appear in ink in that year's column.

The number of Renewal Books will depend on the size of the office in the first place, and in the second on the way in which the work is distributed among the staff. One obvious arrangement is to have twelve books—one for each month. Though apparently the simplest plan, this may not always be the most suitable. Another idea is to divide the business into two sections, and to have an independent set of books for each of the sections. If this is done, it will in most cases be convenient to have only four books instead of twelve in each of the sections. Thus, the first of the four would contain "January, February, March," and so on. In both cases it is assumed that the half-yearly and quarterly cases are to be entered twice and four times respectively. If, however, the quarterly premiums are numerous, it may be advisable to keep them separate from those renewable yearly or half-yearly. If this plan is adopted, three additional books will be required—(1) January, April, etc.; (2) February, May, etc.; (3) March, June, etc. The form of book will be slightly different from that above referred to. There must be two premium columns —one for the quarterly premiums and another for four times the quarterly premium. Also, provision must be made for recording the payment of each of the four quarters' premiums on the same

page. This can be arranged by leaving twice the usual space between the entries as shown in the specimen form. In making up the debit it must be borne in mind that the amounts entered in the Written-off column will, under this modification of the system, be four times the quarterly premium. Only the quarterly amount must be deducted from the former total of the Quarterly Premium column.

PORTION OF RENEWAL PREMIUM CHARGE-BOOK ADAPTED FOR QUARTERLY CASES.

JANUARY, APRIL, JULY, OCTOBER.

	Current Quarterly Premium.	Four times Quarterly Premium.	Dates when Premium Paid.			
			1898	1899	1900	1901
A. B. . .						
C. D. . .						

WRITTEN-OFF BOOK.

All policies which go off the books are entered here, and a chronological record of these is thus furnished. Cancelments naturally divide themselves into a number of well-marked sections. The Written-off Book may therefore be divided as follows:—

1. Claims by Death;
2. Claims by Survivance;
3. Surrenders;
4. Forfeitures;
5. Risks Expired;
6. New Policies not taken up;
7. New Policies Cancelled for others; and
8. Policies Revived.

With corresponding divisions for Reassurances.

The only columns which seem to call for remark are—

Year of Birth.—This is inserted here so that where the policies are for mortality experience purposes classified according to years of birth, the reference to the proper year may be got at a glance.

Page of Premium Charge-book and Policy Register.—The writing-off in these books is done from the Written-off Book, and the pages are inserted here for reference and also to show that the operations have been carried out.

An extra column may be provided, so that where a forfeited policy has a surrender value this may be entered and duly initialled by the actuary. From this column these values are carried to a record which should be kept of Unclaimed Surrender Values, containing the details of the total standing against the account of that name in the principal ledger.

It may seem incongruous to insert Revived Policies in a Written-off Book, but the cases are so few in number that it would be absurd to keep a book for them alone, and besides they are less likely to escape notice when recorded in a book which is in constant use.

Nothing must be entered in the Written-off Book unless the "Benefit" side of the policy goes entirely off the books. It is necessary, therefore, to have another day-to-day record of what may be called alterations. This is provided in the

ALTERATION BOOK.

Like the Written-off Book, it also may be conveniently spaced off into sections, though fewer subdivisions are here required. Thus we have—

(1) Alterations in general, which embrace everything except
(2) Transfers from one class to another, and
(3) Transfers from one Agency to another;
with corresponding divisions for Reassurances.

1. *Alterations.*—Take, for example, a change from yearly to quarterly premiums. The yearly premium is entered in "Premium" column under "Written-off," and the quarterly premium in the "Premium" column under "Written-on." The increase, being the difference between these two columns, will be posted from the Alteration Book into the Additions to Premium column in the Policy Register. The yearly premium will be written off the Renewal Premium Charge Book, and the quarterly premium will be entered in the proper months. In all cases, whatever the alteration, the existing premium must be entered in the Premium Column in the Alteration Book. Sum Assured and Bonuses are not to be entered unless they too are being altered. For example, if bonuses are surrendered, the rest of the policy remaining the same as before, the amount of bonuses surrendered will go into the column "Bonuses" in the Alteration Book.

2. *Alterations from one class to another—e.g.* a change from an ordinary Whole of Life Policy to an Endowment Assurance.

Some may prefer to treat the following cases as simple alterations, merely writing off the premiums and leaving the policies in their original class. I refer to Limited Payment Policies—either when payments are discontinued before the premiums are all paid, or when the premiums are exhausted. There are advantages, however, to be gained by treating them as Transfers to the proper paid-up class. That is to say, writing-off sum assured, bonus, and premium, in the original class, and writing-on sum assured and bonus only among the paid-up policies. The great advantage of this, although it certainly gives a little more labour at the time, is that at a valuation, when it is desired to value the paid-up policies along with those by uniform premium payable during life, the method now described gives the whole of the paid-up policies in one group.

3. *Transfers from one Agency to another.*—As the premium written-on must be the same as that written-off, it is not necessary to enter the premium in more than one column in the Alteration Book. In the Renewal Premium Charge Book alterations of this nature are made by writing-off in full in the one Agency and writing-on in the other. In the Policy Register and in the Numerical Index the alteration is made by simply ruling through the old and inserting the new Agency.

Starting with the business in force at the beginning of the year, if we add the new policies issued during the year, deduct the cancels, and for alterations add the "written-on" columns and deduct the "written-off," we ought to get what is on the books at the close of the year. Thus:—

	No. of Pols.	Sum Assured.	Bonus.	Premium.
Business in force at 1st January,		£...	£...	£... ... ...
Add New Business as per New Policy Register, . . .		... ...	... ...	... ...
Deduct Cancels as per Undernoted Summary, . . .		£...	£...	£... ... ...
		... ...	... ...	... ...
Add: Alterations Written-on		£...	£...	£... ... ...
Less do. Written-off		... ...	... ...	... ...
Business in force at 31 December,		£...	£...	£... ... ...

Annual Balance of Renewal Premium Charge Books.

Before this is attempted it is essential, in the first place, that all the new policies issued during the year be entered, all the cancels written-off, and all the alterations made; and in the second place, that all these entries be compared with the New Policy Register, the Written-off, and Alteration Books. In order to combine the various sections in which the premiums are entered in the Charge Books, the total of each section must be entered in a sheet or book and summed. We should have the total separately for each Agency of the following:—

1. Charge at beginning of year.
2. Written-on during year.
3. Written-off during year.
4. Charge at end of year.

We might of course make a separate list for each of these, but this would involve unnecessary repetition of the name of the Agency. Besides saving this labour, the following plan has other obvious advantages:—

Name of Agency.	Charge on 1 Jan.			Written On.			Written Off.			Increase.			Decrease.			Charge on 31 Dec.		

We have thus in columnar form, which lends itself readily to summation, the separate totals specified above. The Charge on 1st January is the fixed starting-point, its total constituting the premium income on the books at the beginning of the year. The next column should agree with the total of the New Business for the year, plus the Written-on column of the Alteration Book and Revivals, if any. The next column should agree with the total of the Written-off Book, and the Written-off columns of the Alteration Book. Then follow the Net Increase or Decrease during the year, which, added or deducted from the Charge on 1st January, will give the Charge on 31st December. This last column should then be collated with the Premium Charge Book totals at the end of the year, and if they agree the Balance is an accomplished fact. The summations in the Charge Books which up till now have only been made in pencil, can be inserted in ink. That is to say, the new entries must be summed on to what was in force at the beginning of the year—the Written-off column must be summed and ruled-off and its total deducted from the current premium column. The net result should be marked in front 1/1/. . . so as to show where the new year starts. While

that at any time an inspection of the books will show it at a glance.

The various Agents' Debit Notes should be written in copying-ink, and a press copy of them taken in case it should be necessary to refer to them. For the Head-office cashier the debit should be entered in a book kept for the purpose—"*Head-office Renewal Premiums.*"

Renewals Address Book.

The notices for renewal premiums may be despatched at the beginning of each month, or preferably once a week—say on Wednesday—for all premiums due from the following Sunday to Saturday inclusive. The latter plan has the obvious recommendations of better distributing the work, and, in addition, of issuing the notices nearer the due dates.

By recording them in a separate book the Premium Charge Book is relieved of all addresses; and owing to the large space which can be left for the purpose in an Address Book, changes can be easily and clearly recorded.

The Address Book should be divided by a thumb index into thirty-one divisions, one for each day of the month. The day of the month entered in one of the monthly columns indicates the month of renewal. The notices will be written from the receipts themselves, and in this way no notice can go for a premium which may have been paid before the due date.

Sundry Debits.

While all renewals which are issued in the regular course are debited from the Premium Charge Book and also marked-up there when accounted for, we have to make provision for cases out of the usual course, and these we may describe as Sundry Debits. A note of all new policies despatched may also be kept in a book with this title, and if this is done two divisions can be kept for each Agent—one for new policies, and the other for odd renewals. Any further divisions that may be desired can be added—*e.g.* interests, instalments, rents, etc.—but we are only concerned with premiums. Under the heading "New Policies" the first premiums on all new policies sent to the Agent for collection should be entered, and when accounted for either as paid or as not taken up, this should be noted. Under the heading "Renewals," every renewal receipt sent to the Agent for collection, not included in the ordinary monthly summary, should be entered. For instance, suppose a receipt has been returned unpaid, and the assured wishes —some months later—to revive the policy, the unpaid receipt must be issued anew and must be passed to the Agent's debit.

This could be done directly into the Agents' Ledger each time such a transaction occurred, but it is much more convenient to make an intermediate entry in the manner above described. It keeps a record of the transaction, it enables the payment to be marked up when made, and it shows what the sundry outstandings consist of at the end of the quarter when these come to be made up. While these odd payments are thus to be marked up in Sundry Debits, it must not be forgotten that to keep the Premium Charge Books right the fact of the premium having eventually been paid must be noted there also. If this is not done the policy will stand in the Premium Charge Book as lapsed. All danger of such a mistake will be securely guarded against if the renewal section of the Sundry Debits is periodically gone over to see that all payments noted in it have been carried into the proper Premium Charge Book. The other danger of marking off as paid in the Premium Charge Book a premium which is not in the regular monthly debit, and for which no debit has ever been made in the Sundry Debits, can be guarded against by going over the "Details of the Written-off" above referred to, and making sure that no premium included in these deductions has been marked off as paid unless it has actually come through the Sundry Debits Book. If these points are kept in view, then they, taken along with the reconciliation which is made month by month when the charge is being made up, and with the further fact that the amounts in the Premium Charge Books at the end of the year are balanced with the amounts at the beginning of the year, provide all the check that seems necessary. To make assurance doubly sure, an elaborate statement showing the reconciliation of the premiums charged with those received may be made up, but I do not see any advantage to be gained by this.

It will be observed that the Premium Charge Books are described as Renewal Premium Charge Books. The reason of this is that the payment of the first premium is not recorded in them, except indirectly. Thus, there are provided columns for marking-up the premiums for the various years. The first and main portion, as a rule, of an Agent's Account will consist of old policies. Following them, new policies will from time to time be added. Take the case of a policy issued by yearly premiums in March 1898. The first renewal will be due in March of the following year. If, when entering the policy in the Renewal Premium Charge Book, we draw a line from the right of the premium column to the left of the 1899 payment column, we indicate that no premium is chargeable through the Renewal Premium Charge Book until that year. In the case of quarterly policies, care must be taken to make sure that the first premium has been paid before the second is charged, as even although the books of the Office are well up to date it may

happen that a not taken up case may not have got the length of being actually written-off within the quarter.

Arrangements for Receipt of Premium Income.

Assuming that the Agents have been furnished with receipts for collection, and that these have been paid to them, we must look at the provision to be made for conveniently recording the fact of the payments in the Head-office and Branch books. We assume that the debit notes sent to the Agent and returned by him contain two columns — one in which the premiums to be accounted for by him are entered, and the other for recording the manner in which he does account for them. When an Agent's remittance is received at Head-office, it must first be passed through the Cash Book. This may either be done in detail—that is to say, every premium in the account may be detailed in the Head-office Cash Book on the one side, and the commission and charges entered on the other,—or merely the net remittance may be entered in a column provided for that purpose. The latter is, I think, the preferable plan. It confines the Cash Book to the function which its name indicates that it performs, and does not load it with details that are more suitably and naturally recorded in the Agents' Day Book.

In the case of Branches, I would recommend that without detailing the premiums collected by an Agent the gross amount of them should be entered in their Cash Book and the commission and charges on the other side in columns provided for the purpose.

In both Head-office and Branches the use of a subsidiary book, entitled

Premiums Received at Head-office (or Branch),

for recording the payment of premiums received direct, will be found a great convenience. It allows the premiums to be entered at the moment of payment, keeps them separate from all other receipts, allows them to be carried in one entry at the end of the day to the principal Cash Book, relieving it daily of numerous entries which otherwise would swell its receipt side. It also allows the marking-up of the payment of premiums to be done without the use of the principal Cash Book at all. By introducing a Commission column the book can be made still more useful. If this is done, the receipt of the premium and the payment of commission will be recorded side by side, the total of the commission for the day being carried to the principal Cash Book in like manner to the premiums. It is assumed that the commission will be paid at the same time as the premium is received. This is not always the case, however, and the exceptions are troublesome, especially

if the commission lies over for any length of time. To obviate this it will be well to introduce a column in the subsidiary book for Commission credited. In this way it will be made certain that no one is deprived of any commission due to him, and, on the other hand, that no commission is twice paid. To complete the credit for the commission it will be necessary to post the entries in the "Commission credited" column to accounts to be opened for the persons to whom it is due. When payment of these commissions is made they will appear in the Cash Book under the heading "Commissions due," and from the Cash Book they will be posted to the debit of the Agents. If these accounts are gone over, say, at the end of the year, the balances can be accounted for to the Agents. In this way commission can be kept straight, and no belated claims for it can crop up. It may seem almost superfluous to add that in the first instance—*i.e.* when the premium is received—"Commission" must by a Day Book entry be debited, and "Commission due" credited with the unpaid Commission. So far as Head-office is concerned, the subsidiary Premium Cash Book will always be in evidence to speak for itself; but the Branches must send to Head-office, along with the copy of their Cash Book, a copy of the subsidiary Premium Cash Book if the plan above suggested is adopted by them.

Agents' Day Books and Ledger.

Having provided for the proper premiums being charged, and for a record of the receipt of the premiums by the Office, we have now to make certain that all the premiums for which Agents become responsible are duly accounted for by them. It would be quite possible to satisfy ourselves that at any given date all premiums charged were either paid or returned or outstanding if we kept nothing more than a General Agency Account in the principal Ledger—debiting this account and crediting premiums, and *vice versa*. To do so, however, would involve the treatment in one mass of all the premium income of the office, no matter how large that might be, and no matter how many channels it might come through. The most satisfactory plan is to open in an Agents' Ledger an account for each Agent, and debit him with what is sent to him for collection, and credit him when he accounts for the amount so debited. The General Agency Account in the principal Ledger will be a condensation of these individual Agents' Accounts, and will be in fact the counterpart of the great agency system of the office. If we can so analyse all the month's transactions that we can once a month debit and credit the General Agency Account simply with the totals of each of the various kinds of debits and credits made to the individual Agents during

the month, we are at once furnished with the means of making the converse entries for these totals in the proper principal Accounts. The manner in which the items are collected and summarised is as follows:—

We shall begin with the

AGENTS' DEBIT DAY BOOK.

In it are recorded not only the debits made in advance, but also the various odd items of receipt which cannot be foreseen and which must be passed to the debit of the Agent after he has actually received the money and passed it through his account.

The main feature of the Day Book now referred to is its columnar form—the large number of columns provided performing the great service of automatically classifying the transactions so that the total of the various columns gives the amount with which General Agency Account is to be debited for the month and the proper Ledger Account credited.

The "Summary of Renewal Premiums Debited to Agents" is so planned that the posting to the separate Agents' Accounts can be done directly from it, and, therefore, only the total need be entered in the Day Book, thus:—

Jan. 1.	Various Agents.	Renewals for January.	£

(The amount being entered in the Renewal Premium column.)

Once a month, or oftener if preferred, an abstract should be made of the entries in the Register of Policies Issued and the necessary debits made from that abstract in the Day Book. If this abstract is made in a book which is a permanent record of it, the details may be omitted from the Day Book, but if not, each policy should be detailed there.

All odd premiums for which receipts are issued for collection are entered when despatched in the Sundry Debits Book under their proper Agency. At the end of the month the entries should be summed and the totals carried to the Day Book. No receipt or policy is to be issued without being duly entered against the Agent into whose hands it passes. Similarly, no receipt or policy should be returned by an Agent without his being at once credited with such return. A record of these returns is kept from day to day in the Returned Receipt Book. From it an abstract is made monthly of those applicable to each Agent, and the corresponding credits made in detail in the Agents' Credit Day Book. As in the case of the debits of new policies, the question of entering the details of these credits in the Journal will depend upon whether the abstract is made in a book which will preserve a permanent record of them.

It will be observed that reference is being made to the debit in

dvance of premiums only. The same principle can be made to mbrace any other transactions which the management of any articular office may deem desirable. The scope of this paper is, owever, limited to premium and policy records. When we come o journalise the actual cash transactions from the Head-office ash Book, the Head-office Agents' Accounts, and the Branch ccounts, we have to bear in mind that we have debited premiums n advance. The Premium column on the Dr. side of the account nust therefore be omitted from the journalising, otherwise we hould be passing its total twice to the Agents' Debit.

In the forms of Agents' Dr. and Cr. Day Books given, columns re intended to be provided for the transactions which are of nost frequent occurrence. The items for which no column exist vill be entered in the Miscellaneous column, the details being iven in the space provided on the left side of the folio. With a iew to entry in the Day Books, an abstract of the Head-office ash Book and Branch Accounts will be made up once a month or oftener). The Day Books will be summed once a month—the otals of the various columns giving the amounts to be carried hrough the principal Journal to the credit of the respective ccounts and to the debit of General Agency Account, and *vice ersa*, the only column requiring analysis before being thus jourialised being the Miscellaneous column.

If the Agents' Day Book is kept in sections—one for each Branch, tc.—the simple combination of the twelve monthly totals will give, n a very convenient way, an analysed summary of the transactions t each Branch for the year. By keeping these divisions, also, the ntries in the Agents' Ledger are reduced to the minimum of one Dr. and one Cr. entry a month. For the monthly entry in the rincipal Journal the totals can be brought together.

A Returned Receipt Book

hould be kept so as to keep a record of all policies and receipts eturned. The proper credits and markings in the Office books vill be made from the Returned Receipt Book, and a note put in that what is needful has been done. If the Book is made to erve as a record of the return of Interest, etc., Receipts, as well

balance be periodically struck. In this case the most suitable arrangement is to balance once a quarter. The starting-point will be the balance at the debit in the principal Ledger of "General Agency Account." The details of this debit balance will be found in the various accounts for "Head Office," "Head Office Agents," and "Branches" in the Agents' Ledger. The balance at the debit of London Branch, *e.g.*, will consist of—

1. Balance in hand (or in bank);
2. Outstanding Premiums;
3. Other outstandings (if any),

at the beginning of the quarter, and the balance at the debit of London at the end of the quarter will be made up of the corresponding balance in hand and outstandings. As above explained, the premiums have been duly debited from time to time to the Branch, and the Accounts have been analysed on receipt and passed through the Day Book to the Branch Account in the Agents' Ledger. Assuming that no mistake of any kind has been made during the quarter, the balance should come out whenever the entries in the Agents' Ledger and Lists of Outstandings are complete. Mistakes of one kind or another are, however, almost certain to occur, and a great recommendation of the system now described is that it enables a mistake to be localised, and thus absolutely minimises the labour involved in its discovery, and prevents the evils which its non-detection might entail.

The outstandings do not necessarily include all the receipts in the Agents' hands, but only those with which they have up to the end of the quarter been debited. Thus at 31st December the January receipts, although sent away in December, and the necessary particulars retained to make the proper debit, are not passed through the Agents' Day Book until 1st January, and consequently are not treated as outstanding at 31st December. The two following species of transaction require exceptional treatment:—

1. Premiums due, say, in January, but paid in the October preceding. These must be debited (through Sundry Debits and Agents' Dr. Day Book) in October.

2. Premiums due in January, included in regular debit for January but paid in December. To this extent the Agent will have accounted for premiums before he has been debited with them. The best way to treat such cases is simply to show their amount as a difference over-paid at the end of the quarter, and required to square the Account in the Agents' Ledger with the Balance in the Agents' hands.

It may be added that Lists of Outstandings at the end of each quarter should be made up at Head-office, and similar lists

furnished by each of the Branches, the two being collated and any discrepancies investigated.

Let us suppose the balance has not come out at the first trial. We must see what steps are necessary to discover where the error lies. In the first place, as each Agency is treated quite independently, it is not necessary to look at anything outside the Agency in order to find any particular mistake. The whole Quarterly Balance may thus be much more quickly got out than if all had to be dealt with in mass. As many assistants as are available can be put on the work, each dealing with a particular group of accounts. Another very important feature of the system is that not only the original performing of the various parts of the quarter's work, but also the checking of these, can be kept up from day to day. In this way the work entailed at the actual balance may and ought to be reduced to a minimum.

The sort of mistakes likely to arise are—

1. Wrong amounts may be debited in respect of the ordinary renewals sent for the three months. The debit note sent to the Branch must, before being despatched, be reconciled with the Premium Charge Book. It is possible, however, that by a clerical error a receipt may be sent, or may be omitted to be sent, in error. If, when this is rectified, the debit note is simply altered, a due note of the alteration must be taken.

2. Odd receipts may be sent off without being entered in Sundry Debits. To check this, the copy debit notes for the quarter must be gone over.

3. Receipts which have been returned may not have been entered in the Returned Receipts Book. To check this, the letters from the Branch must be gone over.

4. Policies originally written for one premium, and then returned and re-written for the same Number with the same or an altered premium, are troublesome. Care must be taken that, if twice debited, the return of the policy in its first form is duly credited.

5. The wrong amount may have been accepted in payment of a premium, and this fact overlooked when the marking-up of the account was being done.

6. The wrong premium may have been marked-up as paid. The comparison of the two lists of outstandings will, however, call attention to cases of this kind as well as to cases in which the marking-up has simply been omitted.

Balance Book—Agents' Ledger.

In order to strike the quarterly balance of the Agents' Ledger it is necessary to take down the balance on each Agent's Account,

so that the total of these balances may be got in order to see if it tallies with the balance of the General Agency Account. While there are constant changes among the Agents, yet in the course of a year they are not so numerous as to necessitate an entirely fresh list of the names being written out each quarter. It will be found very convenient to use a book of the following form in which to enter the balances. It is designed to serve for one year:—

Agency.	31st March.		30th June.		30th Sept.		31st Dec.	

REASSURANCE DR. AND CR. ACCOUNT.

It is desirable that an Office should know how it stands in regard to Reassurances given to and received from other offices, and this can be readily seen if the particulars be shortly entered in a book of the form given.

REGISTER OF LIFE

Policy No.	Class.	Date.		Branch.	Agency.	Life.	Date of Birth.			Age.	If Admitted.	Sum Assured.		

NUMERICAL INDEX

No.	Class.	Renewable.		Agency.	Fate.

CLASSIFIED POLICY

Year of Entry.	No. of Policy.	Life Assured.	Date of Birth.			Age at Entry.	Original Sum Assured.			Bonus Additions.									Agency.
										As at			Bonus.			Total.			Bonus.			Total.			

POLICIES ISSUED.

First Payment.		Renewal Premium.			Date of last payment.	No. of payments.	Date of Maturity.	Age at Maturity.	Remarks.
Annual Premium.	Single Premium.	Amount.	How payable.	When due.					

OF LIFE POLICIES.

No.	Class.	Renewable.		Agency.	Fate.

REGISTERS.

Premium.			Payments.		Maturity.			Written Off.					
Current.	Additions to Premium.	Payable.	No.	Last.	Age at	Date of		Date.	Cause.	Sum Assured.	Bonus.	Premium.	Pag

CHARGE BOOK.

Premium paid.				Premiums Written Off or transferred to other Agencies.								No.	Written Off.		
1902	1903	1904	1905	1898	1899	1900	1901	1902	1903	1904	1905		Cause.	Date.	Page.

BOOK.

Bonus.	Premium.		Agency.	Page of Renewal Book.	Page of Policy Register.		
	Amount.	When Payable.					

BOOK.

When Renewable.	Written Off.					Written On.					Initials.
	Sum Assured.	Bonus.	Premium.	Page of Renewal Book.	Page of Policy Register.	Sum Assured.	Bonus.	Premium.	Page of Renewal Book.	Page of Policy Register.	

RENEWALS

As-sured.	Life As-sured.	Policy No.	Class.	Sum As-sured.	Pre-mium.	Yearly or	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Last Pay-ment.

MONTHLY SUMMARY OF RENEWAL

Folio of Agent's Ledger.	Agency.	Amount in Renewal Book.	Deduct Written Off since 31st December.

SUNDRY

Name.	Due, Date.	Class.	No.	Premium.

ADDRESS BOOK.

Address.	Remarks.

PREMIUMS DEBITED TO AGENTS.

Amount Debited to Agents.			When and how accounted for.								
			Date.		Paid.			Receipts Returned.			

DEBITS.

Yearly or	When Paid.		Agency.	Remarks.

PREMIUMS RECEIVED

Life Assured.	When Due.		Policy No.	Premium.		

RETURNED RECEIPTS

Date.		Agency.	Folio.	Name.	Policy No.	Due Date.		Yly. or	New Premiums.			Renewal Premiums.		

AT HEAD OFFICE.

Commission Paid.		Commission Credited.			Agent.
Amount.		Amount.		Folio.	

BOOK.

Interest.		Sundries.		Total.			Taken off Books by

Dr. **AGENTS' DEBIT**

Date.	Branch or Agency.	Folio.	Particulars of Policy, etc.			Remarks.	Total.
			No.	Name.	Due.		

Cr. **AGENTS' CREDIT**

Date.	Branch or Agency.	Folio.	Particulars of Policy, etc.			Remarks.	Total.
			No.	Name.	Due.		

Dr. **REASSURANCE Dr. AND Cr.**

(Name of Office.)

Year of Entry.	Number.		Life Assured.	Amount.	Fate.
	Principal Policy.	Guarantee.			

DAY BOOK. *D.*

DAY BOOK. *C.*

ACCOUNT BETWEEN OFFICES. *Cr.*

Year of Entry.	No. of Policy.	Life Assured.	Amount.			Fate.

REASSURANCES EFFECTED BY

Year of Entry.	Principal Policy.			Life Assured.	Date of Birth.	Age.	Agency of	
	Class.	No.	Amount.				Principal Policy.	Guarantee.

REASSURANCE PREMIUM

Due.	Policy.		Life Assured.	Agency.	Guarantee.					
	Class.	No.			Office.	No.	Amount.	Remarks.	Current Premium.	Rate of Comm.

DIRECTORS' SIGNING

Date.			No. of Policy.	Name.

OFFICE.

Particulars of Guarantee.						Remarks.
Office.	Class.	No.	Amount.	Premium.	Payable.	

CHARGE BOOK.

Dates when Premium paid.								Premiums Written Off.								No.	Written Off.		
1898	1899	1900	1901	1902	1903	1904	1905	1898	1899	1900	1901	1902	1903	1904	1905		Cause.	Date.	Page.

BOOK.

Amount of Assurance.		Signed by		Number Signed.

Some Suggestions in regard to Life Office Accounting, including inter alia *an Arrangement of the American* CARD SYSTEM *suitable for the requirements of British Offices*

BY

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Assistant Secretary, Caledonian Insurance Company

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see § 124 on page 251

Some Suggestions in regard to Life Office Accounting, including inter alia *an arrangement of the American* CARD SYSTEM, *suitable for the requirements of British Offices.*

(*Read before the Actuarial Society of Edinburgh, 3rd February* 1898.)

GENTLEMEN,—It is with feelings of diffidence and trepidation that I venture to address you to-night. I have been informed that it is almost impossible to write a paper on anything new in connection with Actuarial matters, as everything bearing on the theory and practice of Life Assurance has already been written, read, and understood by all those interested in the business. However, although nowadays every Actuarial student can graduate a Mortality Table in about three different ways, and can run off lists of the Securities, in which the funds of an Office should and should not be invested, with reasons as to their choice or rejection, I think that perhaps in the department of Life Office Accounting there are still a few suggestions which can be made. I allow that the subject is not so scientific as, say, the calculation of the probable future profit to be received on a Reversion, which has been bought at an auction, or the valuation of conflicting interests in a Disentail. I am also afraid that Accounting is not thought of much importance by Actuaries, but is regarded rather, may I say, as a prosy, though easily crammed subject, to be read up before examinations.

Previous Publications on the subject.

1. I have only come across two complete treatises on Life Office Book-keeping among the books and papers with which I am acquainted, and these are the papers by Mr. MacLauchlan and Mr. Smith Nicol. I do not include Dr. Sprague's valuable book on Life Insurance Accounts, published 1874, as it deals rather with *results* than *methods* of accounting.

Mr. MacLauchlan's paper is the well-known classic on the subject. Mr. Smith Nicol's paper gives an elaboration, with variations, of the system propounded by Mr. MacLauchlan. Both gentlemen really advocate one and the same system, so I will afterwards refer to it as the Edinburgh system. I have been fortunate enough to have seen Mr. Smith Nicol's method of book-keeping in practice, when auditing, and I have no hesitation in saying that, as an example of the ordinary British many-columned system, it appears to me to leave little to be desired.

2. I however hold that, as every Office, or nearly every Office, is increasing its business at a very rapid rate, and, as the Public is more and more feeling the necessity for Life Assurance, a decided effort should be made by all to still further simplify, if possible, the practice of book-keeping. On the other hand, as the cost of getting New Business is also unfortunately increasing rapidly, methods of checking that cost should be elaborated. In the calculation of Premiums, no amount of trouble has been spared to calculate the Mortality rate correctly, and any actuary on examining a table of Office Premiums can tell how much of each is theoretically spent on Mortality; but very few indeed could tell exactly how much of a Premium received goes in commission, rents, salaries, advertising, etc., in the first year. Each Office has no doubt different "cost" rates, but that is the very reason why each should know that rate exactly. I do not, however, propose that Offices should publish more information than at present they are compelled to give to the Board of Trade, nor that they should prepare these regulation Statements in any special manner.

OBJECTS TO BE ATTAINED.

3. The system of book-keeping suggested in the paper, which I am about to read to you to-night, has been arranged with a view of combining the most modern methods, that I have been fortunate enough to see in America and at home, with the requirements of British Life Offices.

4. As Mr. MacLauchlan says in his paper, before mentioned, which is considered the text-book on this subject, "The objects to be attained by Life Assurance Book-keeping are:—

"(1) To afford ready information as to the financial transactions of the Office with every individual with whom it does business, providing, in the case of persons with whom there are continuous business transactions and periodical settlements, a regular account.

"(2) To record fully the intromissions of the Officials with the funds of the Office.

"(3) To classify the various transactions of the Office so as to produce at the end of the year (*a*) a Revenue Account, and (*b*) a Balance-Sheet in the forms prescribed in the Life Assurance Companies Act, 1870, with such further details in the case of each as it may be desired to place on record."

To these must be added (and they are very important):—

(4) To enable the Directors or at least the Manager to know, with full particulars, the total cost of New Business and the expense of carrying on Old Business.

(5) To enable the Company's Auditor, without inconvenience to his staff or that of the Office, to make a thorough audit in a

reasonable time; and besides, the system should be such that the clerks will not be apt to make mistakes, and when, an error has been made, they should be in a position to readily notice and quickly locate it.

NOTE.—My suggested fourth object is, theoretically speaking, embodied in Mr. MacLauchlan's third object; but the question of expenses is so important that I consider they should have a separate clause to themselves. The other part of Mr. MacLauchlan's third clause I do not consider so much as an object of importance, but rather as a necessity or requirement, which might be stated as follows:—"To classify the various transactions of the Office, so as to produce at the end of the year, without any work having to be done a second time, the regulation Statements of the British Government, and the Government of any other State or Country in which the Office transacts business."

ANALYSIS OF REVENUE.

5. Referring to Mr. MacLauchlan's third object, namely, that of producing at the end of the year the regulation Statements along with such further details as it may be desired to place on record, I consider that items, the totals of which are to be exhibited either publicly or privately at the end of the year, should be kept separate in journals and subsidiary books and ledgerised in separate accounts during the year, so that it should not be necessary to go over an account, still less a cash-book or journal at the end of the year and make therefrom a list or abstract of items when a summary is required. The fact of this having to be done is, generally speaking, a sign of bad book-keeping.

6. In the system I am about to show you, I endeavour, by cutting down all unnecessary work—such as that of writing details twice—to keep separate throughout, without making the book-keeping more complicated, a great many classes of similar items which at present are often confusedly jumbled together.

The items which I keep in separate classes are:—

(1) PREMIUMS which are divided into Single, New and Renewal, and again into Whole of Period and Limited.

(2) COMMISSION which is divided into that on New Business and that on Renewals, and again into that on Whole Period and Limited Premiums.

(3) New Business done is divided into Profit, Non Profit, and again into Whole of Life, Temporary, Endowment, and Double Endowment, or any other special class. Consideration for Annuities into Single and Annual Payments.

NOTE.—Whole of Period Premiums are intended to include Premiums payable during the whole term of the risk, whether they be payable under ordinary Whole of Life Policies or Term Assurances, but not to include Premiums payable under Endowment Assurance Policies. "Limited Premiums," on the other hand, are intended to cover Premiums payable for Endowments, deferred Annuities, and, generally speaking, Premiums for Assurances which have a

banking element. The division of Premiums into Whole of Period and Limited, of course, is arbitrary. Other divisions may appear more advantageous to you; but I do not think it is desirable to have more than two divisions.

(4) EXPENSES which are divided into (I) Rents, etc.; (II) Salaries, Directors' Fees; (III) Advertising; (IV) Stationery; (V) Stamps, etc.; (VI) Legal Expenses; and again into those applicable to Premiums Collected Statement, Insurances Paid Statement, Investments Made Statement, and Interest Collected Statement.

7. All the above classes should be shown in each Statement for the Branches or for the Head Office, or for the Society as a whole, except in the cases of Expenses in Insurances Paid Statement, Investments Made Statement, and Interest Collected Statement, which three Statements are only made up for the Society as a whole.

8. My object is to check exactly the cost at which the Branches bring in New Business and carry on the existing Business, and to avoid, if possible, Expenses being proportioned among Branches at the end of the year at the discretion of the Head Office Accountant, who then may make mistakes in his rough estimates. I give here copies of the Statements mentioned above. These explain themselves.

9. PREMIUMS COLLECTED STATEMENT

FOR EACH BRANCH, HEAD OFFICE, OR THE SOCIETY AS A WHOLE.

	£	s	d
Agents' Balances at the beginning of year, ...			
Premiums outstanding at do., .			

Premiums charged, less cancelled—	Gross. £	s	d	Reassurance. £	s	d	Net. £	s	d
Renewals, Whole Period, . . .									
Do., Limited, .									
Sums Assured £ *New*, Wh. Pd., .									
Do., Ltd.,									
Single, .									
Consideration for Annuities—									
Single Premiums, ...									
Annual Do., ...									

Commission—	Gross. £	s	d	Reassurance. £	s	d	Net £	s
On Renewals, Whole Period, ...								
Do., Limited, . . .								
On New Business, Whole Period, . .								
Do., Limited, . . .								
On Annuities, Single,								
Do., Annual, .								

Expenses—	New Business. £	s	d	Renewals. £	s	d	Total. £	s	d
Rents, etc., .									
Salaries and Directors' Fees									
Advertising, .									
Stationery,									
Stamps, etc., .									
Sundries, if any,									

	£	s	d
Balances written off, ...			
Agents' Balances outstanding at end of year, ...			
Premiums outstanding at do., .			
Net Premium Receipts, ...			

10. (SOCIETY'S) INSURANCES PAID STATEMENT.

	Gross.	Reassurance.	Net.
Claims, ... £			
Surrenders, . . .			
Annuities, . . .			
£			

Expenses—

Rents, etc., ... £	
Salaries, etc., ...	
Legal Expenses, £ , less Assignment Fees, £ ,	
Stationery, ...	
£	

11. (SOCIETY'S) INVESTMENTS MADE STATEMENT.

	£	s	d
Investments realised, .			

	£	s	d
Investments made, . .			
Policy Loans granted, .			
Nonforfeitable debts constituted, . . .			

Expenses—

	£	s	d
Rents, etc., . . .			
Salaries, Fees, etc., .			
Legal Expenses, . .			
Sundries, . . .			

12. (SOCIETY'S) INTEREST, ETC., RECEIVED STATEMENT.

	£	s	d
Assets at beginning of year, ...			

	£	s	d
Assets at end of year, .			

Interest, etc., received—

	£	s	d
Interest and dividends,			
Feu-duties, . . .			
On Policy loans, . .			
On N. F. debts, . .			

Cost of Collection—

	£	s	d
Rents, etc., . . .			
Salaries, etc., . .			
Other expenses, . .			

TRUE RATES OF EXPENSES AND COMMISSION.

13. It is generally agreed that the ratios between figures given in a Statement of Accounts or Statistics are more instructive than

the figures themselves. And from the above Statements the following very instructive ratios which ought to be known by the Officials of every company may be readily produced.

1. For Head Offices and each Branch and for the Society:

As regards New Business.

(Premiums payable for Whole Period, Limited Term, and by Single Payment, taken separately and also together.)

Ratio of Commission on New Business to amount of New Business done.

Do. of Commission on New Business to New Premiums.

Do. of Expenses applicable to New Business to New Business done.

Do. of Expenses applicable to New Business to New Premiums.

Do. of Commission and Expenses applicable to New Business to New Business done.

Do. of Commission and Expenses applicable to New Business to New Premiums.

As regards Renewals.

(Limited and Whole of Period separate.)

Ratio of Commission on Renewals to Renewal Premiums received.

Do. of Expenses applicable to Renewals to Renewal Premiums.

Do. of Expenses and Commission applicable to Renewals to Renewal Premiums.

NOTE.—With regard to the Premiums Collected Statement, Commission is applicable to the Premiums charged, less cancelled, during the year; but Expenses are applicable to the Premiums collected during the year. This is not quite satisfactory. Of course, the true rate of Expenses to total Premiums actually collected can be deduced from the Statement as the necessary figures are given; but there would be some difficulty in making up these rates for the Premiums actually collected in classes. This will be more obvious when we come to the Agents' Accounts and other Statements. But, after all, such refinements are not really necessary.

As regards Annuities.

Ratio of Commission on Annuities granted to Consideration for Annuities granted.

Do. of Expenses on Annuities granted to Consideration for Annuities granted.

Do. of Commission and Expenses on Annuities granted to Consideration for Annuities granted.

2. For the Society as a whole:

Ratio of Expenses applicable to Claims paid, Surrenders granted, Bonuses given in Cash and Annuities paid, etc., to total of such sums paid.

Do. of Expenses applicable to Investments made, Loans granted, etc., to such payments.

Do. of Expenses applicable to Interest collected to Interest collected.

ALLOCATION OF EXPENSES.

14. Probably it may be said that it would be very difficult to divide so many similar expenses into separate classes in order that they might be charged against the classes of transactions, on account of which they had been incurred. In the first place it would be necessary to open an account for each class of each kind of expense. It then may be contended that it would be difficult to post an item of expense to its proper account or to divide it correctly among several accounts. But, on the other hand, I advocate, that several kinds of expenses, often kept in separate accounts, should be posted together. For instance, Inspectors Fees' could be put in with Salaries or Commission on New Business; office-cleaning, coal and lighting, directors' lunches, etc., could be kept together, and afterwards divided along with Rents, etc., as explained below. Telephone, telegrams, postage stamps, etc., could also be slumped. Of course the clerks who are responsible for these Expenses would in any case keep rough note-books giving full particulars. Besides, by means of an "Outlays Cash Book" (see § 59) a great deal of ledgerising can be avoided without slumping similar classes of expenses.

15. As regards dividing one item among several expense accounts, I think, when you consider Expenses as a whole, you will find that there are no great difficulties to contend with. Besides, to thoroughly keep count of expenses, one may consider them as divided into two classes, namely, "constant" and "variable." The former do not require so much attention as the latter. The Constant Expenses are not always easily apportioned, but this does not much matter, provided they are apportioned on the same principles each year. Fortunately, the Variable can generally be easily debited against the items of Revenue, on account of which they have been incurred. For instance, "Rents, etc.," which are *constant*, should be mostly charged against New Business, and might be debited as follows:—New Business 60%, Renewals 20%, Insurances paid 10%, and Interest collected 10%. This of course is an arbitrary division. Nearly all the other items of expenditure are *variable*, but can be posted direct to the Accounts in which they appear at the end of the year. Thus all advertising, show-cards, prospectuses, policy forms, stamps, and doctors' fees should be among the expenses charged against New Business from the outset.

The account of the Society's Solicitor can be readily divided

between Expenses applicable to Insurances paid and Investments made. Clerks' and Inspectors' salaries can be readily divided among the Expense accounts according to the work to which most of their time is given.

Pensions payable to retired members of the staff may be for purposes of comparison deducted from Interest, etc., received.

16. The result of dividing expenses on these lines would probably be that the cost of New Business would be found to be larger than is generally supposed, but the Officials might find means, if they had full particulars before them, of keeping this cost from getting larger every year, as it tends to do at present.

One could readily notice when the Expenses of a Branch, mortality being considered, were more than the New Premiums received through that Branch were worth.

Bear in mind that I do not for a moment suggest that these Statements and Rates should go any further than the Directors, unless the latter specially wish them published, which is unlikely.

17. It would be better indeed if a Profit and Loss Account could be made for the Head Office and each of the Branches, either in place of or along with these statements; but to do that would require, as you know, an Actuarial valuation. However, it is not necessary for us to go into the question of valuations at this stage.

GENERAL REMARKS.

18. There are a few suggestions with regard to Life Office books, some of which apply to any set of books, which, with all due deference to my seniors, I will take the opportunity of mentioning here, as they form a code of rules according to which I have tried to work out my system. These briefly are:—

(1) As the Company's Auditor has to approve of any system of books which the staff think of adopting, and will not hesitate to condemn any arrangement which does not meet with his approval, the requirements of the Auditor and his convenience must be considered in the first place.

(2) The more simple the system is to audit, the more thorough will be the Audit, and the less will the Auditor be required to trouble the staff with "Notes" and questions, and, what is more important, the simpler the Audit, the less will be the time during which he will want the books or papers in constant use.

As regards the writing of the Books.

19. (1) No official or clerk who handles cash, or what he could readily convert into cash, should be in a position to do posting.

However, it is not always possible to keep this rule in small Branches.

As regards keeping Cash.

(2) The Cashier should keep the Cash-Book proper. To do this he need only make the entries and put the figures in the total Cash and the Bank columns. These columns should be at the side of the pages near the entries. His clerk can fill in the figures in the subsidiary or Journalising columns. To enable this to be done the Cash-Book should be in two volumes, the volumes being for alternate days of the week. It matters very little that figures made in two handwritings should appear on each page. A Cash-Book kept in this way would be inclined to look a little untidy, but it would be a safer arrangement than the usual one, where there is a rough Cash-Book with which to keep the Cash and a Copy-Book used for posting and auditing, especially so, if the copying is done three or four months after the original entries are made in the rough Cash-Book. Possibly it might happen that the clerk did not keep the subsidiary columns up to date, but he would not be nearly so likely to get behindhand with these columns as with a whole Copy Cash-Book. There is an objection to having two Cash-Books for the alternate days of the week, and that is—that in looking back to find particulars of some item one might not be in a position to know in which book to look. This can be got over to a certain extent by having the posting numbers in the subsidiary books marked in such a way that there can be no doubt as to which Cash-Book they refer, such as having *even* folios in one Book and *odd* folios in another. Another method would be to have the Cashier write his transactions on separate sheets all carefully numbered, instead of keeping Cash-Books for alternate days. These sheets would be bound up into books once a month or once a year, or once a month and again at the end of the year. But if it is thought best to dispense with a Scroll Cash-Book, the use of which at Head Office, at any rate, I consider unnecessary and undesirable, these separate Cash-Sheets would have to be large, as it would be necessary for the convenience of the Cashier to have both the Debit and Credit sides, and all the subsidiary columns appearing on each single sheet. In the event of a Branch Cashier having to send his Cash-Book periodically to Head Office, a Scroll Cash-Book is almost necessary, unless either the book he keeps behind or the sheets, which he sends, consist of tissue copies (see also under Branch Cash-Book, § 48).

"To" and "By" in posting unnecessary.

(3) The words "To" before debits and "By" before credits should never be written. They are a mere waste of space and a

these numbers. These ought to be on the face of the voucher at the end away from the spikes of the file. This arrangement especially applies to receipts written on forms given by the Office. It is not good in the case, say, of a receipted building account, or a printing account; but such receipted accounts, under ordinary circumstances, are generally kept by themselves for reference. Every year, or quarter, or even month, the vouchers should be taken off the file and put in one of the cases, which are sold for the purpose, a numbered blank sheet being first put into the place of any voucher awanting, with a note explaining its absence. It is a great saving of time to keep vouchers thus in books. They are also more easily audited in that state. A single spiked clip is handier than a double spiked American or Canadian file, and less than a quarter of the price.

Although it is a waste of time to back vouchers or other papers which are to be bound up in books, or kept open in files, all other papers should be carefully backed.

The Ruling of Books.

(8) With regard to the Books, the fewer they are the better, as long as they fulfil all the purposes for which they are intended. The fact that there are many and bulky books does not prove a system to be good—rather otherwise. The many-columned system of book-keeping has enabled, or should enable, the actual number of the books to be very much reduced. It tends, however, to make books large and heavy. In America, for example, where the many-columned system is very much in vogue, I once had to audit a journal, in which each department of a large city had a separate column. This book, when shut, was about 3½ feet long by 2½ broad, about 7 inches thick, and took two men to lift it. It would have been comparatively handy, however, had it been bound in six or twelve large flat volumes.

In the event of an accountant having settled upon an arrangement of columns in a many-columned book, he acts very unwisely if he leaves anything to the common sense of the printer and the bookbinder. A book of the sort can be altogether spoilt by too little space being left for the pounds and the entry. On the other hand, too much space is invariably left for the shillings and pence, the date, and the reference numbers. It is very important that all details of this sort should be most carefully attended to. Again, the entry column should be wide enough to allow nearly all the entries to be written in one line. If it takes two lines to write the average entry, the book-keeper has to turn over a new page twice as often, and twice as much book is used and twice as much safe space taken up.

It is very important that all books and papers should be kept in fire-proof safes, unless they can be very easily reproduced, which is seldom the case. The Americans are far more particular about safes than we are. Again, the fewer and handier the books and papers are, the more easily and the more readily they can be put away.

Books in thin volumes.

(9) As regards binding, the general inclination is to bind far too many pages into one book. There is no reason why the pages should not be large, but let the books be thin and flat, with even perhaps soft leather bindings. In that way the larger books will be in several volumes, which, besides having the advantage of handiness, enables several men to use a book where only one could otherwise do so. In many cases a thick Ledger, the majority of the pages of which is filled with entries that have become ancient history, is daily dragged out and in of the safes. When a thin-volume system is used this waste of energy is saved. What I afterwards call a Card ledger (§ 72), or a ledger which comes to pieces, is a development of the thin-volume system.

LABOUR-SAVING APPLIANCES SUGGESTED.

20. The methods, or special arrangements, by which I think it possible to cut down the labour of the Edinburgh system of Life Office book-keeping are briefly as follows :—

(1) The Policy, Renewal, Investment, and Agents' Registers, Life Assured Index, and Interest Debit Book to be on cards.

(2) Different-coloured cards to be used for the Renewals, as afterwards explained.

(3) The Agents' Ledgers and the Ordinary Ledgers to be on cards, or rather separate sheets, with certain limitations.

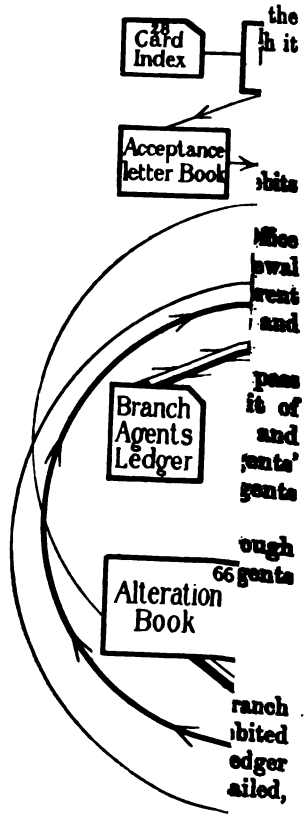
(4) Full advantage to be taken of the Policy numbers.

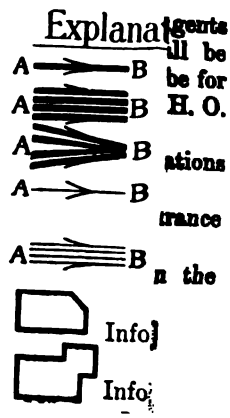
(5) Journalising between Ledger Accounts, and between Journals and Ledgers to be as much as possible done away with.

(6) Details not to be written twice.

(7) Special alteration Cards to be used.

(8) Carbon or Press Copies to be used rather than manuscript copies wherever possible, and the headings and rulings of Statements, of which copies are required, to be printed in ink which will press copy.


Card Index
Acceptance letter Book
Branch Agents Ledger
Alteration Book


Explana
A B
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Info

tern Mutual Life Insurance Company of Milwaukee.

ystem I will call the Card System. It is very similar in
cts to a method adopted by the Northwestern Mutual
e Company of Milwaukee, an office with a business
any Society having its head office in Edinburgh.
his in order to prove that it cannot be said that a
n is not applicable to a large office.)
h impressed by the beautifully fitted and handsome
s Society, almost as much as by the great courtesy
of the officials, who gladly, and with justifiable pride,
he arrangements necessary to work their extremely
d yet simple, system of accounting. I say "account-
there were so many cards, and such a comparatively
r of books, that it would hardly be correct to call it a
ook-keeping." They had also a splendidly arranged
partment, where they appeared able to construct all
ctuarial statistics very rapidly. The Actuaries' cards
eparate from those used by the Accountants. This
ay mention, is more famous for its elaborate system
night call Investing Representatives or salaried special
Agents, than for either its Accounting or Actuarial

ard Ledger, the use of which I suggest, is a modifi-
ngstroth's Mechanical Ledger. The Company, with
at present connected, uses one of these Ledgers for
gents in San Francisco. A full description thereof
ections 72 to 77.

PROCEDURE.

is an abstract of the procedure which I recommend,
llowing a Policy from the time when the proposal
the Directors, till a Renewal Premium thereon is
r by the Agent. § 41. *(See insert opposite.)*
e, Agency, Sum to be assured, and class of policy
ntered in the Business Book, which along with the
ers is submitted to the Directors. Their decision is
he Business Book opposite the particulars of the pro-
chairman.
ly afterwards a notice of acceptance or declinature is

sent in the usual way—a press copy being kept in a special letter-book.

NOTE.—On the acceptance letter, which is sent to the Proposer by means of the Agent or direct, is a note of the first Instalment of the new Premium, which sum, less Commission, passes to the Debit of the latter, per the New Business Debit Book, when the new Policy is sent out, see opposite. When an acceptance is sent through a Branch (let us call it Branch N), on receipt of the new Policy (or special Receipt if there is a special hurry), Branch N debit themselves or the Agent with the instalment of new Premium less Commission, if any, and credit Head Office. Head Office debit Branch N, per the New Business Debit Book, with net sum, and Branch N New Commission Account with the Commission; and credit Branch N New Premium Account with total instalment of Premium. The Branch does not require to keep a "nominal" account for Premiums (see Branch Accounts, § 42 and § 45). All "nominal" and statistical accounts will be kept at Head Office.

24. If the proposal is accepted, a Policy is written in the usual way, a copy thereof being made on a Copy Policy form, afterwards bound into the Copy Policy Book (which is the only register of the Policies in book form), and is to be used to record all transactions with the Policy of which the Company receive notice. A full description of Copy Policy Book, § 78, is given under Register of Assignments, under §§ 79 and 80.

The Policy is numbered according to class—that is, Ordinary whole of Life—say from 300,000, Limited Payment Policies from 600,000, Endowments from 900,000, and Double Endowments from 1,200,000. This special numbering is an aid in the procedure of keeping an exact account of the cost of collecting premiums.

25. As to the renumbering of the records of Policies already issued, so that they arrange themselves if put in such numerical order, this can be brought about as follows:—Initial letters can be put before the old Policy Numbers, "A" being put before the numbers of all Ordinary Whole of Life Policies, "B" before the numbers of all Limited Payment Policies, and so on. So that Ordinary Whole of Life Policies would be numbered A 25674, A 76532, A 85467, etc., Limited Payment Policies, B 34568, B 45692, Endowments C 23456, etc., and so on. Then, when the card records of these Policies are put in drawers or boxes, the A's would always come before the B's, the B's before the C's, and so on. In the Policy Register proper, however, the Policies would have to remain in their original numerical order.

26. The new Policy is immediately sent out to the Branch, or Agent, and simultaneously the debit is made in the New Business Debit Book. A small tick is made in the Business Book that the Policy has been properly sent out.

27. NEW BUSINESS DEBIT BOOK.

This book would be of the nature of the Agent's Renewal Debit Journal, given § 36.

ate.	Branch.	Agent.	Ledger Folio.	Policy Number.	Assured.	Due Date.	Net Total.	Portion of Premium payable.		Commission.		Remarks.
								Whole Period.	Limited.	Whole Period.	Limited.	

This book is posted to the Premium Accounts once a month. There will be so few Single Payment Premiums that it is not necessary to have separate columns for them. They can be picked out of the Limited Column at the end of each month.

As regards the New Premiums which are paid in two half-yearly portions or in four quarterly portions, columns are arranged for the second and other instalments of them and their corresponding Commission in the Agents' Renewal Debit Journal (see § 36).

A column might be added to the above for medical Fees of Head Office Agents, but I think on the whole it is better not to pass this item to the credit of the Agent until he has paid it, and to do so through the Outlays Cash Book, § 59. With regard to the Commission of Branch Agents, the Head Office might be at a loss to know the arrangement made by the Branch with the Agent as to the rate on the first Premium. However, I would suggest that to all their Life papers the Branch should add a slip on which they would fill in two blanks as to the rates of Commission for the first year, and for Renewals. This information would be well worth the attention of Head Office Officials when the Proposal was being considered. And besides, once the rates of Commission are known, it enables the Premiums to be charged to Agents, less Commission, right through the system of the Branch Accounts. This I consider desirable, and a convenience in the system I am putting before you.

Index of Lives Proposed.

28. When the Policy is sent out an Index Card is put in the Life Proposed Index. The information on the Index Cards will be:—

Name and Christian Names.
Date of Birth.
(Remarks).
Class.
Declined Number, or
Policy Number (afterwards corrected to
Not-taken-up Number if necessary).
Sum Assured.
Date of Acceptance, or Declinature.
Amount Reassured.

The card will be white if the Proposal has been accepted at ordinary rates; blue if rated up, or accepted at ordinary rates in one class, in place of being rated up under another.

In this same Index brown cards will be put for declined lives,

so that in one Index will be given all the lives of which the Office has papers. If the life has already been proposed, particulars of the new Policy will be put on the card on which his name is already given.

These cards will thus give at a glance information which has often to be looked for in two or three Registers when a Proposal comes in.

POLICY REGISTER.

29. As soon as the Head Office know that the first Premium has been paid, or is likely to be paid,—as to which definite information will be given by the Branch within a month (see also under Policies not taken up, § 63)—particulars of the Policy are immediately put on the card, which is added to the Policy Register, being put in the drawer thereof applicable to that class of Policy, the particulars on the card being taken from the Copy Policy Book, which is marked to that effect.

POLICY REGISTER CARD.

These are kept in the Numerical Order of the Policies.

No. Life (*assured*) (*Profit or non-Profit*)

£ (*sum*) (*Particulars more fully than on Renewal Debit Card*)

Policy dated

Born.

(*Valuation Age*)

Annual Premium. £ Age n.b.d. at entry.

Assuree.

Agent. (*Branch*)

Premium Payable. } (*Particulars as to Premium*)

(*Remarks*)

Dates of Alterations.

Calculation Book.

(*On the back will be given information* re *Bonuses in columnar form.*)

The Policy Register Cards will be used for the most part by the Actuaries, for the calculation of surrender values, etc., and for their convenience the cards on which "with-profit" policies for males are recorded can be white, "non-profit" green, and in the same way the cards for females can be pink and brown. These cards will be kept carefully up to date (for method see § 65). As the Register Cards constitute an Index to all Policies *in numerical order*, once a Policy is taken up the Register Card remains for ever afterwards among the other Policy Register Cards, even if the life dies, when it is marked to that effect. This Register is not to be used as a Register of Assignments, the Copy Policy Book being used for that purpose as explained in § 80 (1). Nor is the card meant to be used for Valuations, as the Actuaries should always keep them in their correct numerical order. They can use copies of them for Valuations (see also "On" and "Off" Cards, § 70). The card can be smaller than a Renewal Debit Card (§ 31).

New Business Completed Book.

30. The Policy is next recorded in the New Business Completed Book. This book is divided into Head Office and Branches, and again into months. It enables a very elaborate analysis to be made of the New Business, and is many-columned, so that Sums Assured, Premiums, and First Year's Commission may appear separately for the three or four different classes of Policies.

These may be suggested as headings for the columns:—

(*On top of page*) HEAD OFFICE (*or Branch*). *Month.*
(*Year.*)
AGENT.

POLICY NUMBER.
LIFE.

Whole Life	Ordinary	Sum.
		Annual Premium.
		First Year's Commission.
	Limited Payment	Sum.
		Annual Premium.
		First Year's Commission.
	Temporary	Sum.
		Annual Premium.
		First Year's Commission.
	Endowment	Sum.
		Annual Premium.
		First Year's Commission.
	Double Endowment	Sum.
		Annual Premium.
		First Year's Commission.
	Contingent and Miscellaneous	Sum.
		Annual Premium.
		First Year's Commission.

Note.—There can be other columns for Annuities, or they can be in a separate book.

Renewal Registers.

31. A Renewal Premium Debit Card is then written, and is inserted in its numerical order among the other cards of the same Agency, in the set of drawers applicable to the month when the first premium falls due, and the Register Card of that Policy marked to that effect. If the Premium is payable yearly a white card is used, if half-yearly a red card, and if quarterly a green one. In this way a red card in a June drawer is also a December Debit, and it is unnecessary to put a second card in a December drawer. But when making up the December Debit Sheets the clerks would look in the June drawers for the red and green cards, and the March and September drawers for the green ones.

(*For the Renewal Premium Debit Card see opposite.*)

Note.—On the design given opposite, and on the other designs in this treatise, the words bracketed and in italics are not supposed to be printed on the cards to be used by the Office. That is (*Assured*) is only meant to indicate the position on the card where the name of the Life Assured would be written.

By "Assuree" I mean the party or parties for whose benefit the Policy is kept in force. It is a handier designation than Policy-holder, and the meaning of the word is more exact.

32. An "On" Card (an Alteration Card) is then at once written and put in the On division of the drawer in which the Renewal Debit Card was put. The "On" Card is of the same colour as the principal card. I suggest On and Off cards, which will be small memorandum cards, on which a jotting of every alteration affecting the Premiums Receivable should be made, as a means of helping the Accountants to reconcile the Renewals of any month with those of the same month for the previous year, and I promise to enable them to do this without any difficulty.

After the Reconciliation is made (see also § 69) the On and Off Cards should be removed from the Renewal Drawers, but carefully kept somewhere else. In the event of a Cancellation the principal Card can be removed as soon as the Off Card is written, but it would probably be found more convenient to keep it in its place till after the Reconciliation was balanced.

Note.—As to whether it is necessary to write "On" Cards for New Policies, and "Off" Cards in the event of Premiums being cancelled or reduced, I think it is advisable to do so, as they can be made a great service to the Actuaries, which I have explained at some length in § 70.

RENEWAL PREMIUM DEBIT CARD.

(*Front*)

(*Branch*)

(*Assured*) Per (*Agent*)

Assuree DATES OF ALTERATION.

(*Address*)

(*Remarks*)

ium.	Commission.	Due Date.		N. F. Debt.	N. F. Interest.	Loan.	Loan Interest.
			(*Mark here if charged.*)				

(*Columns with their heading continued on the back.*)

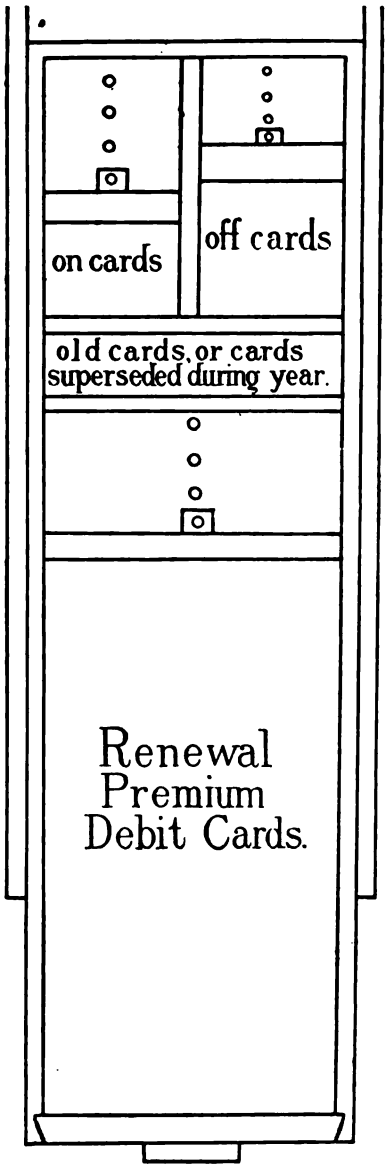
These cards are to be used for the most part by the Book-keepers for the ebit of Premiums, Loan Interest, etc.

Premiums to be ruled out in red ink if paid.

N. F. Debt = Non-Forfeitable Debt, *i.e.* Premiums in arrear carried forward as a debt payable out of policy money.

N. F. Interest = Interest on such debt.

33. DESIGN FOR DRAWER FOR RENEWAL PREMIUM DEBIT CARD.



Except for the divisions at the back, the Drawers would be of the usual American pattern for Card Registers. Such drawers could be best made in America.

The "On" and "Off" Cards would be small, as they would only require a jotting to be recorded on them of the alteration made on the principal card. They would be of the same colours as the principal cards.

For further particulars, see under "Alterations," §§ 69 and 70.

A drawer of this design is also suitable for Interest Debit Cards (§ 93).

RENEWALS.

34. The Renewal Premiums will be debited to Branches and Agents as follows:—As before mentioned the Renewal Premium Debit cards are kept divided into months, then into Branches, and then into Agents, and then arranged according to number. As, however, certain coloured cards, as above explained, will be debited along with these taken from the drawers of other months, the numerical order cannot be got just at once. The object of the numerical order being correctly kept is, that the totals of different classes can be easily obtained without the necessity of double Premium columns in the debit sheets of small Agents. However, there is no objection to there being such columns in the Branch Debit Sheets.

On the Renewal Debit Cards, of which a copy is given opposite § 31, are given, besides the Premium and Commission corresponding to each Renewal date, Non-forfeitable Debts, with N. F. Interest and also Policy loan Interest, due at such dates. This, I think, is better than having separate cards for these debits.

Branch Renewals.

35. Let us begin with the Debits for Branches. The principal headings of the sheets are:—Agent's Sheet No., Policy No., Assured, Due date, Total (mark if paid column), Whole Period (premium), Limited (premium), Commission Limited and Whole Period, N. F. Debt, N. F. Interest, Policy Loan Interest, Sundries and Remarks. The particulars of the Premiums are first written on to the Premium Receipts from the Renewal Cards. As the Cards are arranged according to Agencies, the Receipts are thereby similarly arranged. The Receipts written from the coloured cards of the other months are then put together with the first Receipts applicable to each Agency, and rearranged in correct numerical order. The sheets are then written from the Receipts, and finally, as a check, the sheets are compared direct with the cards. (The summations only of the many columns on the sheets are posted, see § 37).

NOTE.—As the Branch Sheets are many-columned, it is not essential that the Premiums of each Branch Agent should be given in correct numerical order. It is obvious that classes of premiums, if separated for posting purposes in the Branch Sheets, need not also be separated in the Branch Agents' Sheets. It is different, however, with the Head Office Agents, as postings are made direct from their sheets without the aid of a Head Office Branch Sheet.

36. The following are the headings for Branch Renewal Debit Sheets, and the Agents' Renewal Debit Journal into which they are posted.

BRANCH RENEWAL DEBIT SHEET.

		Agent's Sheet No.
		Agent
		Policy No. X
		Assured X
		Due date X
		Agents' Ledger Folio
		Agents' Total X
		Net Total (Mark if paid) X
Renewal Premiums	Premiums	Whole Period
		Limited
	Deduct Commission	Whole Period
		Limited
Instalments of First Year's Premiums	Premiums	Whole Period
		Limited
	Deduct Commission	Whole Period
		Limited
		Non-forfeitable Debt
		N. F. Interest
		Loan Interest
		Fines
		Sundries
		Remarks

AGENTS' RENEWAL DEBIT JOURNAL

		Date X
		Sheet No.
		Branch or Agent
		Agents' Ledger Folio
		Total
Renewal Premiums	Premiums	Whole Period
		Limited
	Deduct Commission	Whole Period
		Limited
Instalments of First Year's Premiums	Premiums	Whole Period
		Limited
	Deduct Commission	Whole Period
		Limited
		Non-forfeitable Debt
		N. F. Interest
		Loan Interest
		Fines
		Sundries
		Remarks

The Branch Renewal Debit Sheets and the Agents' Renewal Debit Journal are very similar in rulings and headings. The columns not common to both I have marked with an X.

37. The Premiums, etc., are arranged in the Branch Sheets according to Agents, so that they may be easily copied on to the Agents' Sheets by the Branches, and also that the Branches' Agents' Sheets thereafter may be easily checked by the Head Office book-keepers with the Press or other copies of them retained at Head Office.

The Agents' Renewal Debit Journal is for totals only, which are taken from the Branch Sheets and Head Office Agents' Sheets as they go out. As months have to be kept separate, this book can be in twelve volumes.

NOTE.—In order to get separate Revenue Accounts for Branches from the many columns in the Renewal Debit Journal and other subsidiary Journals, each Journal would have to be divided according to Branches. This in an ordinary office would not be very desirable. The Branch Premiums Collected Statements (see § 9), however, can be made up from the totals on the monthly Branch Debit and Cancellation Sheets at the end of the year with ease, provided that the Sundry Debits and Credits during the year (see §§ 56 and 51) are added to the totals of the Renewal and Cancellation Sheets, which, to keep the Branches correct, would probably require to be done in any case. Besides, there are very few sundry Credits which would not appear in the Cancellation Sheets even if these are only used for Receipts returned (see §§ 51 and 52). Note also the Prudential system, § 107.

38. The Branches will write their Renewal Notices from their Receipts, and their Agents' Sheets from their Branch Sheets when they receive them. It is hardly necessary to mention that the Branch Sheets must be sent out early.

Policy Loans, Claims, and Surrenders go through the Head Office Cash-Journal and the Sundry Debit Journal (see § 57 and Note).

Addresses.

In some offices it is not considered necessary or possible to keep the address of each Assuree, but you will notice that I put a space for it on the Renewal Premium Debit Card, § 31.

From this the address is written on the Premium Receipt, and the Assuree will be asked in a printed note thereon to let the Office know of any change. It will also be the duty of the Agent to notify changes in the addresses of the Assurees whose premiums he collects.

The object of keeping the Assuree's Address is that, when a Premium is said to be in arrear, the Notice of Lapse or N. F. Debt can be sent direct to the Assuree, which is both a check on the Branch and the Agent. See also § 89 (2).

It would often happen, however, that the Office had not the Assuree's correct address, but in these cases the notice of Lapse, etc., would be returned to Head Office through the Post Office, and could be sent out again through the Agent.

Another way of keeping the Assuree's address would be to send him all Renewal Notices direct, and to ask the Agent for an explanation every time one was returned through the Post Office.

Another reason for having the Assuree's address is that he can be approached direct by the Branch or Head Office and encouraged to keep up a Policy, of which the Premium is in arrear, and also approached direct with a view to New Business.

Agents' Sheets.

39. With regard to the small Head Office Agents' Sheets, as the Premiums, etc., are written in proper numerical order, one column can do for different classes. By breaking the column in the middle the Book-keepers can easily find the total of each class of Premium. With these totals they make up an Abstract on a counterfoil to the sheet, which is used for posting purposes. The counterfoil and a press copy of the sheet are retained when it is sent out.

More than the usual amount of information *re* Commission is given on the Agents' sheets. This, however, besides being a convenience in the system of accounting, I suggest, should also enable the Agents to keep correct, and thereby be a greater convenience to those who have to check their Statements.

40. This is an example of a Renewal Debit Sheet for an important Agency:—

40. AGENT'S RENEWAL DEBIT SHEET. (*Important Agency.*)

(*On first page*)

Sheet No. (*Agent's Name*) (*Branch*)

(*District*) (*Address*)

(*Instructions to Agent printed here*)

Policy No.	Assured.	Due date.	Net Total.	Renewal Premiums.			(*On Head Office Agents' Sheets.*) Instalments of First Year's Premiums.			N. F. Debt.	N. F. Interest.	Loan Interest.	Sundries.	When paid, and Remarks.
				Premiums.	Rate Com.	Commission.	Premiums.	Rate Com.	Commission.					
							(H.O.)	(H.O.)	(H.O.)					

(*On right side inner page*, i.e. *on third page*)

MEMORANDUM OF ANNUITY RECEIPTS SENT TO AGENT.

Due date.	Payee.	Annuity.	Income Tax.

Agent's Credit.

The total of the Agent's credit must equal his total net debit plus commission, or, when he has only to collect Premiums, the total of the Premiums without deducting commission.

The Agent will kindly fill up these columns.

	£
Cash returned,	
Annuities paid (less tax),	
Commission taken,	
Postages, etc.,	
Sundries,	

Policy No.	Reason.	£

Receipts returned, .

(*Agent's Signature*)

FOR HEAD OFFICE AGENTS.

(*Attached to right hand of third page, retained by Head Office as counterfoil*)

Abstract Columns to be filled in by Book-keepers.

Sheet No.
Agent,
Month,

	£	Premium Charged.	Commission thereon.	Receipts Returned. Premium.	Receipts Returned. Commission.
Renewal Premiums—					
Whole Period,					
Limited,					
Instalments of first year's Premiums—					
Whole Period,					
Limited,					
N. F. Debts,					
N. F. Interest,					
Loan Interest,					
Fines,					
Cash sent to Agents,					
Sundries,					

(*Space here for additional entries*)

41. A simpler form of sheet can be sent to some of the Agents, as in the smaller Agencies there may not be any N. F. Debts or Policy Loans.

This is an example of a Renewal Debit Sheet to be used in such cases.

AGENT'S RENEWAL DEBIT SHEET. (*Small Agency.*)

Sheet No. (*Agent's Name*) (*Branch*)

(*District*) (*Address*)

(*Instructions to Agent printed here*)

Policy No.	Assured.	Due Date.	Net Total.	Premium.	Rate Com.	Commission.	(*Spare Column.*)	Sundries.	When Paid, a Remarl

Agent's Credit.

The total of the Agent's credit must equal his total net debit plus commission, or, when he has only to collect Premiums, the total of the Premiums without deducting commission.

The Agent will kindly fill in these columns.

Cash returned, ... £

Commission taken, ...

Postages, etc., ...

Sundries, ...

Policy No.	Reason.

Receipts returned, . .

(*Agent's signature*)

FOR HEAD OFFICE AGENTS.

Abstract Columns to be filled in by Book-keepers.

(*As counterfoil of sheet retained by Head Office*)

heet No.
gent,
lonth,

	Premiums Charged.	Commission thereon.	Receipts Returned.	
			Premiums.	Commissio
Renewal Premiums—				
Whole Period, ...				
Limited, ...				
Instalments of fi st year's Premiums—				
Whole Period, ...				
Limited, ...				
N. F. Debts, ...				
N. F. Interest, ...				
Loan Interest, ...				
Fines, ...				
(*Space here for additional entries*)				

BRANCH OFFICE ACCOUNTS.

42. We now come to the Branch Accounts. I am inclined to think that all Book-keeping which has to be done by the Branches should be made as simple as possible, in order that the energy and time of the staff may be reserved for other purposes—such as that of getting New Business and collecting Premiums.

Again, five book-keepers working together at Head Office can do more work, and do it better, than ten men distributed over several Branches, and the ten Branch book-keepers would require at least one other man at Head Office to check their accounts.

Bearing this in mind, I think one should require the Branches only to keep such accounts as cannot be kept at Head Office. With this in view, I hardly think it necessary for them to keep "nominal" accounts—such as Interest, and Premium Accounts. They must, however, keep Cash and Bank Accounts, and "Personal" Accounts for their Agents, as Agency Accounts, unfortunately, cannot very conveniently be all kept at Head Office. However, some offices, notably the Prudential (*see* § 104), keep Ledger Accounts for all their Agents at Head Office, an arrangement which is much to be commended.

Mr. Cameron's Branch Accounts.

43. The best system (for Life Business only) of Branch

Accounts I have seen was arranged about twenty-five years ago for the Scottish Widows' Fund by the late Mr. John Cameron, who had formerly been in the service of the Life Association of Scotland. This system is worked by means of a many-columned Cash-Book, and a many-columned Journal, the headings of which are :—

CASH ACCOUNT. (*Branch Office.*)	JOURNAL. (*Branch Office.*)
(*Entry.*)	(*Entry.*)
Policy No.	Policy No.
No. of Voucher.	No. of Voucher.
Folio of Agent's Ledger.	Folio of Agent's Ledger.
Dr.	Dr.
Cr.	Cr.
POSTINGS TO GENERAL ACCOUNTS.	POSTINGS TO GENERAL ACCOUNTS.
Debit Postings—	Debit Postings,
Agents.	Agents.
Bank.	Bank. X
Commission.	Cash. X
Expenses.	Commission.
Head Office.	Expenses.
Interest, etc.	Head Office.
Premiums.	Interest, etc.
Suspense.	Premiums.
(Blank.)	Suspense.
(Blank.)	(Blank.)
Credit Postings (same as Debit Columns).	Credit Postings (same as Debit Columns).

The headings, I think, explain the two books, which are balanced once a month. A list is made of the Agents' Balances which, of course, equals the Balance of the Agent Columns, together with a list of Premium Receipts in hand which equals the balance of the Premium Columns, a list of Interests outstanding corresponding to the Balance of the Interest Columns, and Analyses of Expenses and Commissions. Copies of the books and these Abstracts are sent to Head Office once a month. In this way the Branches only require to keep a Ledger for their Agents' Accounts ;—the rest can be done at Head Office.

The Suspense Account is used as a convenient means of posting items which have to be entered before their due date.

Mr. Cameron's arrangement suitable for Card System.

44. It is almost unnecessary to remark that Mr. Cameron's method would work in very well with the Card System. If you look again at his columns you will notice that I have marked the Bank and Cash Columns in the Journal with a cross. This I

Date.	Ent	).	ANALYSIS OF RECEIPTS								
			Premiums, Gross.			Interest, Fines, etc.			Loans and Debts.		
1896		d.	£	s.	d.	£	s.	d.	£	s.	d.
Dec. 31	Balances, . .			...			...			...	
1897											
Jan. 1	Renewals, less comm			...			...			...	
	month, . .										
	Reassurances, less co			...			...			...	
	this month, .			...			...			...	
	Medical Fee, Smitl			...			...			...	
4	N. F. Debt and Intere			...			...			...	
	Premium Receipts re										
	per list Novembe			...			...			...	
	Do. for alteration,			...			...			...	
				...			...			...	
5	Loan authorised by H			...			...			...	
	(Remitted by) Head O			...			...			...	
	Loan granted, .	0		...			...			...	
	Petty Cash, .			...			...			...	
	Liverpool, London, a										
	Stamp, . .			...			...			...	
	Scottish Widows D			...			...			...	
	New Policies. Prems.			...			...			...	
				...			...			...	
				...			...			...	
	December Accounts,		10	10	2		...			...	
			21	0	6		5	0		...	
6	Norwich Union Re	0		...			...			...	
	Annuity (paid, less			...			...			...	
	Ground Rent, .	0		...			...			...	
	Balance written off			...			..			...	
	N. F. Debt and Intere			...				6	10	10	2
		0	31	10	8		5	6	10	10	2

lance.

| | | | | | | | | | | |

one as I consider them not absolutely necessary. The le of his system really means that he only works with ten Accounts, and "Personal" Accounts for Agents.

e ten Ledger Accounts are—Cash, Bank, Agents, Com- n, Expenses, Head Office, Interest etc., Premiums, Suspense, nother to be chosen as may be found necessary.

Branch Combination Cash Book.

. Now I think it quite possible to improve Mr. Cameron's gement, and only have one book, which I will call a Com- ion Cash-Book, to serve for his two books. The accounts h I suggest for this Combination Book are:—Cash, Bank, d Office, Agents, Expenses, and Suspense.

EAD OFFICE would be debited with (*a*) Payments due to be made by Branch, which would be credited to "Suspense," and (*b*) Receipts returned, less commission, and (*c*) balances written off as bad, etc., credited to Agents; and would be credited with Premiums, less commission, falling due, which would be debited to "Agents."

"AGENTS"—would be for all receipts of the nature of Income, such as Premiums. The Branch would have an account for themselves among the Branch Agents.

BRANCH EXPENSES would not include Agents' ordinary Commission, but would include all other expenditure.

"SUSPENSE"—would be for Payments the Branch had to make, such as Annuity Payments, Loan Payments, etc.

46. For the convenience of Head Office clerks, when checking nd posting the Branch Accounts, there should be columns analys- ng the receipts and payments, which may be divided as follows:—

Receipts.	Payments.
Premiums (Gross).	Agents' Commission.
Interest, Fines, etc.	Agents' Expenses.
Loans, Debts.	Medical Fees.
Sundries.	Claims, Surrenders, Loans and N. F. Debts.
	Sundries.

And, in addition, one "Journalised" column.

The book will have in all twenty-two columns, as in Mr. Cameron's books. All Cash and Bank entries will appear in at least three of the columns. I now give an example of the book, with a few specimen entries. (*See insert opposite.*)

48. The first objection which may be raised to this Cash-Book is that it would have to be so often used as a Journal that there

would not be time for the Cashier to use it as a Cash-Book. If such a difficulty should arise, the Cashier can have a Scroll Cash-Book which would be identical with the Combination Cash-Book, taking the columns to the left of the Analysis of Receipts columns only, but including the voucher column. There is no real objection to the principle of the book, as very nearly all the transactions that a Branch has to record are Cash transactions. The delivery of a bundle of written Receipts by Head Office to the Branch, which would be (or should be) kept by them as valuable instruments, though not recorded in either the Cash or Bank columns, is theoretically a Cash transaction. Besides, in the specimen entries given above, there are more than the usual proportion of Journal to purely Cash items. The book should be kept loose in sheets in the first place, in order that it may be conveniently copied, as Head Office must get a copy. Perhaps the most convenient way of doing this would be for the Cashier to keep a Scroll Cash-Book, as suggested, and only press copies of the sheets of his Combination Cash-Book, the originals being sent to Head Office. In this case the headings and rulings of the sheets would be printed in ink, which would also press copy. A large sheet can always be pressed in sections in an ordinary press.

49. You will notice that in the second specimen entry is "Agents debtor to Head Office for Renewals due this month," £5201, 11s. 6d. This entry would really be made at least a month earlier, as the Renewal Statement and Receipts (see §§ 35 to 37) would (or should) arrive some time before the Premiums, etc., are due. All the Cashier does, however, is simply to pass this entry through the Book. The statement is then handed out to the clerks, who from it debit the Agents in their Agents' Ledger, which, as in the case of Head Office, should be a Card Ledger. You will notice two total columns, and an Agents' Ledger Folio column, given on the Branch Sheets (see § 36), to enable them to debit one net sum.

I may here mention that, of course, it is not essential for the working of this system that Premiums due, less Commission, should be entered in the Cash-Book and Ledger. The gross Premiums may be debited to Agents if preferred.

50. The Agents' Sheets and Renewal Notices are also written from the Branch Sheet; the Receipts, being already written by Head Office (see § 35), have only to be signed.

The Branches keep their Debit sheets afterwards carefully in the form of a book, which constitutes their Agents' Renewal Debit Journal, debits on account of new Premiums and occasional Debits being made through the Combination Cash-Book.

I think you will now agree that, if the Branch sheets are written in the form proposed, the portion of the work left to be done by the Branch will be very simple. Nor is their usual work

put on the shoulders of the Head Office Staff, as the special arrangement of the Renewal Cards (see § 34), which is the foundation of the system, lightens their duties also.

CHECKING OF BRANCH STATEMENTS AT HEAD OFFICE.

51. Besides the Combination Cash Sheets the Branch sends once a month a list of Premiums cancelled, along with the corresponding Agents' Sheets and returned Receipts. The following are the necessary headings for these sheets and the Agent's Credit Journal, into which the totals thereof are entered :—

BRANCH CANCELLATION SHEET.			AGENT'S CREDIT JOURNAL.
		Date	Date
		Agent's Sheet Number	Branch or Agent
		Policy Number	Ledger Folio
		Assured	TOTAL
		Due date	FOR H. O. AGENTS: Medical Fees
		Agents' Ledger Folio	FOR H. O. AGENTS: Agent's Expenses
		AGENT'S TOTAL	SUNDRIES
		NET TOTAL	Remarks
NEW POLICIES NOT TAKEN UP	PREMIUM	Whole Period	CANCELLATIONS (*Same headings as in the money columns of Branch Cancellation Sheet*)
		Limited	
	COMMISSION	Whole Period	
		Limited	
RENEWALS	PREMIUM	Whole Period	
		Limited	
	COMMISSION	Whole Period	
		Limited	
INSTALMENTS OF FIRST YEAR'S PREMIUM	Premium	Whole Period	
		Limited	
	Commission	Whole Period	
		Limited	
		N. F. DEBTS	
		N. F. INTEREST	
		LOAN INTEREST	
		FINES	
		OTHER RECEIPTS	
		Remarks	

In regard to Receipts Returned.

52. The entries in the Sheets are according to the dates on which the Agents returned their Receipts, and correspond with the entries in the Combination Cash Book. The Head Office Bookkeepers check the Agents' sheets with the Combination Cash Book for Cash and Commission, Medical Fees, and Agents' Expenses, for which payments they are to a certain extent vouchers, and simultaneously the returned Receipts with the Branch list of Premiums, etc., cancelled. They next compare the Branch Agents'

Sheets, the Branch list of Cancellations and corresponding Commission with the figures they originally debited to the Branch in the Branch Renewal Debit and New Business Debit Sheets. They then mark the Premiums on the copy Branch Debit Sheets paid or cancelled, and after a reasonable time mark the Renewal and other Cards from these markings.

It might be said that it would be enough to see that the Branches accounted for all the Receipts sent them, and that it is not necessary to check their debits to Agents individually, but I do not think it would be expedient to assume that the transactions of ordinary Branches with their Agents were in order.

In regard to the posting of Branch Accounts.

53. As regards the posting of the Branch Accounts, Premiums and Commission were posted to their various Accounts through the Agents' Debit Journal, when the Branch Sheets were sent out, and again to the same Accounts through the Agents' Credit Journal from the Branch lists of Cancellations, when these came in, so that, though the Branches are allowed to slump the different classes of Premiums and Commissions in their Combination Book, the net debit and credit to each of the various accounts are correctly obtained for the Head Office Books automatically.

As regards the other Branch Transactions, if you look again at the Combination Cash Book (§ 47) you will see that it is not necessary for Head Office to post the Expense Accounts, or, rather, the Abstracts thereof, of which there will be twelve each year, until the end of the year.

54. NOTE.—Particulars of Expenses furnished by Branch along with their monthly statements are—

	£
Rents and Taxes,	
Salaries,	
Coal and lighting,	
Travelling,	
Advertising,	
Stationery,	
Medical Fees (*as per column*),	
Agents' Expenses (*as per column*),	
Postages, etc,	
Sundries,	

55. As regards the large sums, such as Claims, etc., also Reassurances and Annuities paid by Branches, which appear in the Branch Suspense Account, these are already posted to the Head Office Accounts through the Head Office Cash Journal, see § 57. The Balance of the Branch Suspense Account represents sums, authorised to be paid by Head Office, not yet paid. The Branch will also furnish a list of these.

Similarly, the Balance of the Branch Account "Agents" equals

the value of the Receipts in the hands of the Agents and the Branch. A list of these will be given, say, quarterly (see also § 88).

The Balance of the Branch "Head Office" Account should equal the Balance of the Account for that Branch at Head Office.

OTHER IMPORTANT BOOKS.

56. The following are the remainder of the more important books necessary for the working of the system :—

SUNDRY DEBIT JOURNAL.

- Date
- BRANCH AND AGENT
- Policy Number
- Assured
- Due Date
- Ledger Folio
- REMARKS
- TOTAL
- ASSIGNMENT FEES
- RENEWALS
  - PREMIUMS
    - Whole Period
    - Limited
  - DEDUCT COMMISSION
    - Whole Period
    - Limited
  - OTHER PREMIUMS
  - OTHER COMMISSION

  } For "revivals" and Alterations
- LOANS, ETC., REPAYABLE
- LOAN INTEREST
- N. F. DEBTS — For N. F. Debts paid off at odd periods.
- N. F. INTEREST — For N. F. Interest paid with such debts
- FINES
- TRANSFERS
- SUNDRIES

57. HEAD OFFICE CASH JOURNAL.

RECEIPTS.		PAYMENTS.	
	Date		Date
	(Entry)		(Entry)
	(Policy or Bond number)		(Policy or Bond number)
	CASH		CASH
BANK paid in	London	BANK drawn	London
	Edinr.		Edinr.
	Sundry		Sundry
	(Ledger Folio)		(Ledger Folio)
	SUNDRIES		(Voucher Number)
	INVESTMENTS		SUNDRIES
	POLICY LOANS		INVESTMENTS
	INTEREST ON INVESTS.		POLICY LOANS
	H. O. Collections and Agents		REASSUR. PREMIUMS
	Income Tax, paid		CLAIMS
			SURRENDERS, ETC.
			ANNUITIES
			Transferred to Outlays
			Commission received
			Income Tax, received

NOTE :—Specimen Entries in Cash Journal. The Head Office is assumed to write cheques for most payments to Assurees to make sure that they are cashed by the rightful payees.

Policy Loan Granted or Investment made per Branch.

(1) Debit Branch and Credit Bank with cheque payable to Borrowers.

(2) On receipt of Agreement.

Debit Cash.	Credit Branch.
Debit Loans.	Credit Cash.

Loan repaid per Branch.

(1) Debit Branch and Credit Loans Repayable, per Sundry Debit Journal.

(2) When transaction completed.

Debit Loans Repayable.	Credit Cash.
Debit Cash.	Credit Loans.

58. HEAD OFFICE COLLECTION BOOK.

Date.	Assurree or Agent.	Policy Number.	Agents' Ledger Folio.	Voucher.	Premium received direct.		Agents' Remittances.
					Premium.	Commission.	

59. OUTLAYS CASH BOOK.

	Date
	Entry
RECEIVED.	CASH
	BANK
	ASSIGNMENT FEES
	Ledger Folio
	Voucher Number
PAID.	CASH
	BANK
GENERAL	Rents and Taxes
	Salaries
	Directors' Fees
	Heating and Lighting
LEGAL EXPENSES.	Investments
	Claims, etc.
	Travelling
	Special Commission
	Advertising
	Stationery
	Medical Fees
	Policy Stamps
	Petty Cash
	Miscellaneous

The object of this book is to save ledgerising Expenses from the Cash-Book proper, and also to save space in that book. There will be no difficulty in keeping this book, as the payments in it are nearly all made by cheque on accounts rendered, so that the Cashier can make the payments and write the book at his convenience.

POLICIES REINSURED.

60. In the event of a sum being reinsured in another Office, the particulars of the premium receivable would be written on a card marked with a large St. George's Cross in Brown, and the particulars of the premium payable to the other office on a Card marked with a St. Andrew's Cross of the same colour. Both Cards would be kept together. They might even be fastened together like reply postcards.

In the event of the Office guaranteeing another Company, no special card is necessary. The other Office would simply be treated as an Agent.

As regards Policies Reinsured, however, when the Branch Debit Sheets are made up from the Cards, the Policies reinsured are marked say with an "R," and Reinsurance Credit Sheets, with similar Columns, etc., are prepared at same time.

Cashier to have Reinsurance Credit Sheets.

61. The Reinsurance Credit Sheets are not sent to the Branches, but are kept by the Head Office Cashier on a file for reference. All the Reinsurance Premiums will pass through his hands thus:—

1. Premiums payable direct by Head Office are paid by the Cashier in the usual way. If they are payable through a Branch, he debits Branch and Credits Bank with cheque payable to Reinsuring Company for Premium, less Commission.
2. When the Branch state that Premium has been paid, the Head Office Cashier debits Reinsurance Premiums for total Premium and Credits the Branch and Commission received per cross entry in the Cash Journal.
3. The Reinsurance Credit Sheets are marked, when the Reinsurance Premium has been actually paid, and similar sheets are filled in for Cancellations.
4. The Sheets are put on the Cashier's file in months. At the end of the year they are taken off and rearranged according to Branches. From the totals of the columns on the Sheets statistical Accounts for the Branch Reinsurances can then be readily made up for the Branch Premiums Collected Statement. (See also Note, § 37.)

Annuities Paid.

62. A Card Register of Annuities payable is kept at Head Office, arranged according to date of payment. If there are many, these will again be divided into Branches and then into Agencies. However, we will assume that there are comparatively few Annuities payable at Branches. A list is made up for the Cashier from the Cards (or an Annuity Payable Book, altered to suit the latest information on the Cards). From this list, on getting the usual evidence of existence, he pays the Annuities on their due dates.

Note.—Entry in Head Office Cash Journal for Annuity paid through a Branch.

(1) Debit Branch and Credit Bank with cheque payable to Annuitant for Annuity, less Tax.

(2) When Annuity has been actually paid, Debit Annuity, Credit Cash and Income Tax (gross sum), Debit Cash and Credit Branch (net sum).

POLICIES NOT TAKEN UP.

63. A Record of these is kept, giving number of Policy sent out, name of Assured, Assuree, etc., and Not-taken-up Number.

When a Policy is sent out the Copy Policy is put in a portfolio along with others of the same class, where it remains until there has been plenty of time for the proposer to either pay the Premium or the Agent to return the Policy. After it has been in the portfolio, say, three months, it will be bound into a Copy Policy Book, unless the Policy is returned not taken up. In that case the Copy is taken out and a fresh blank Copy put in its place, bearing the same Policy number; this will be used later for another Policy. The discarded Copy will be numbered with a Not-taken-up number, and recorded in the Not-taken-up Book and put away with the Life Papers.

The Policy which has not been taken up, clearly cancelled, is afterwards produced to the Auditor and then sent to the Stamp Office.

In this way Policy Register, Premium Charge Cards, etc., will not, under ordinary circumstances, be written if the Policy is not taken up.

The Audit of New Business done.

64. The Auditor will see that every Proposal passed by the Directors either appears in the Policy Registers or the Record of Policies not taken up. To help him to do this, Policy Numbers or Not-taken-up Numbers can be put in pencil opposite the cases in

the Life Business Book. This will prevent his assistants upsetting the order of the Policy Register Cards.

When he has checked the Business Book on to the Policy Register Cards, he can then run over the Cards and see that no Policies have been issued without the approval of the Directors, which is the more important part of the audit, from his point of view.

NOTE.—If it is considered undesirable under any circumstances to use a Policy Number a second time, the copy of the Policy not taken up will have to remain in the Copy Policy Book, and also a card bearing its number (and marked as not taken up) among the cards of the Policy Register proper. This will, of course, considerably increase the number of the Records of extinct Policies in these Registers.

ALTERATIONS.

65. It may be suggested that there is always a possibility of an alteration being made without being properly recorded, or effect given to it in the Accounts, whatever system of book-keeping you may have in the Office.

But as no alteration should be made without the Policy being called in and indorsed to that effect, whoever signs the indorsation should always satisfy himself that the Alteration has been recorded. It is not possible to make a hard and fast rule that no indorsation should be signed until all the registers are marked which are affected by it; but there should be a rule that the Copy Policy is similarly indorsed and a record made in an Alteration Book before the principal indorsation is presented for signature. From this I think it is apparent that an Alteration Book is absolutely necessary. An Alteration Book is first of all a diary in which alterations, including bonuses surrendered, claims paid, premiums reduced, etc., are noted. There is (or should be) a column in it for the initials of a head clerk that all Registers, etc., affected by the alterations have been marked. It is unnecessary to mention that these markings should be made as soon as possible after the alteration is made.

66. As regards the Book-keeping proper, the original premium Receipt is returned if the Alteration is made as it usually is, just after a Premium falls due. It is handed to the Book-keepers, who should immediately make the necessary entries.

I do not know all the different ways of checking the Alteration Book, but one way I understand is to balance it at the end of the year with a list of Alterations, made on Sums Assured during the year, which is written on sheets of paper, from the Policy Registers. As regards Premiums altered, the Alteration Book is often made

a means of reconciling Premiums, charged during any month of one year, with those charged during the same month of the previous year.

The following are the headings in an ordinary Alteration Book :—

Date.	Pol. No. Class.	Name.	Alteration.	Deductions.				Initials.	Additions.				Init
				Bonus.	Sum.	Annual Premium.	Due.		Bonus.	Sum.	Annual Premium.	Due.	

The Reconciliation of Alterations.

67. Now I think it will appear that, for balancing the alterations in Sums assured in a large Office, a great deal of trouble at the end of the year may be saved by having the Alteration Book divided into, say, ten divisions, each of which will cover, as nearly as possible, an equal number of Policy Register Cards. The Alteration would be recorded in the part of the Alteration Book indicated by the Policy Number. As regards the Premiums, however, it would be more convenient to have the Alteration Book divided according to the months in which the altered Premiums might fall due, or according to Branches. Both these latter divisions, however, would cause trouble. I think, on the whole, it would be much more convenient to divide the Alteration Book according to Policy Numbers, which, as I suggested that Policies should be numbered according to classes, would mean that the Book would, to a certain extent, be divided according to classes. On the samples of the Policy Register Card (§ 29) and Renewal Premium Debit Card (§ 31) you will notice that I have put in a conspicuous manner "Dates of Alteration." I have also done the same on the Copy Policies (§ 78). At the end of the year two separate lists could be made up of the Alterations on Sums Assured, the one being taken from the Copy Policy Book, and the other from the Policy Register Cards, and balanced with the Alteration Book in divisions. Thus, provided you are sure that no alteration in a Sum Assured can possibly be made without being either recorded in the Alteration Book or the Copy Policy Book, you can make absolutely certain of the correctness of both, and, at the same time, the Policy Registers.

As regards the Alteration of Premiums.

68. When an alteration with regard to the Renewal Cards is made the Policy is treated by the staff in the first place, as mentioned above.

The most common alterations are—

New Policy issued, when a new card is written from the Copy Policy Book.

Premium altered from yearly to half-yearly or quarterly, or *vice versa.* Sum Assured altered. Age altered. Policy altered to E.A., or *vice versa.*	Policy called in and altered to that effect. Copy Policy and Register Card also altered. Alteration recorded in Alteration Book. New Renewal Card written from Copy Policy Book. "On" or "Off" Card written. Old Card put in space for purpose, § 33.
Claim or Surrender paid.	Policy sent in by Claimants. Alteration recorded in Alteration Book. Off Card written. Renewal Card put away.
Bonus surrendered for cash.	Policy called in and indorsed. Copy Policy also indorsed. Alteration noted in Alteration Book. Policy Register marked. Renewal Card not necessarily affected, but should be marked.

The Reconciliation of Premiums charged.

69. There appear to me to be two good ways of balancing according to months the alterations of Renewals with an Alteration Book, divided according to Policy Numbers. The first is to have the columns for "premiums written on," and "premiums written off," in the Alteration Book, divided into twelve columns each, according to the months affected by the alteration. This would be inclined to make the book bulky, and also to make what ought to be a simple entry—as it is a very important entry—a complicated one. I think the following method would be found better. When an alteration is made, it is recorded first of all in the Alteration Book, and the Indorsation on the Policy is marked on the Copy Policy, with which it is compared. These should both be done before the Alteration on the Policy is signed, or at least before the altered Policy is sent out. Immediately afterwards an "On" or "Off" Card is written from the Copy Policy, the Policy Register Card altered,

and the Renewal Premium Debit Card altered or rewritten. The "On" or "Off" Card is put in the drawer in which the Renewal Premium Debit Card is kept (see § 33). The Alteration Book is then marked that all this has been done. Now, from the "On" or "Off" Cards, which are thus arranged according to Agencies, lists can be made up by means of which the premiums debited to an Agent or Branch in any month can be reconciled with those charged during the same month in the previous year, and as a natural sequence the Premiums charged in one whole year to all the Branches with those charged in the previous year.

The use of "On" and "Off" Cards for Valuation Purposes.

70. No doubt you will at once think that it would be simpler to record the alterations into a many-columned Journal from the Alteration Book rather than put them on to "On" or "Off" Cards at all, from which lists of some sort must be made; but, when the alterations are on "On" or "Off" Cards, they can be arranged in any way which may be desired, and, if the date of Birth and date of Entry (and date of Maturity with Endowments), or such other information be added as the Actuaries may desire, the "On" and "Off" Cards may be made the basis of a continuous method of Actuarial Valuation.

Mr. Chatham's System of Valuation.

71. When writing on Life Office accounting, it is hardly possible not to bring in the question of Valuations. It would be presumption in me to discuss methods of valuation, as the subject has been so thoroughly thrashed out by so many Actuaries of well-known experience. However, let me for a moment refer you to Mr. Chatham's Prize Essay on the subject, with which, no doubt, you are all well acquainted. I understand from his reference to Cards in the *Journal* of the Institute XXXII., on p. 406, that he advocates the use of Cards, but that they are not absolutely essential to the working of his System. I regret that he does not say much more about them in this particular paper. The cards with which most of us are familiar are those arranged for Mortality Investigations only. I refer to the Institute Cards. Besides, although it is obvious that cards, which are to be used for a System of Valuation like Mr. Chatham's, must have far more on them than what is necessary for Mortality

Investigations, I think it is generally believed that one card of the nature of a Register Card is all that is necessary even for a continuous method of Valuation. Now, I am sure "On" or "Off" Cards, or let us call them Alteration Cards, of which you might have several referring to one Policy, would be found of very great service in the construction of Mr. Chatham's Valuation Registers, especially his Claim Valuation Registers. I may mention that the American Office I have before referred to used twelve different kinds of Alteration Cards, besides a Register Card for its Actuarial Valuations. These cards, however, were kept in the Actuarial Department, and were quite separate from the Accountants' Debit Cards. (See also § 21.)

THE CARD LEDGER.

72. A Card Ledger is a Ledger the accounts in which are written on separate sheets, which may be taken in and out of a special Box or Set of drawers arranged for the purpose.

The six principal recommendations to such a Ledger are given by J. A. Langstroth, who takes credit for inventing this sort of Ledger, as follows:—

(1) The immediate or periodical separation and retirement of closed Accounts, and the ready return of such as may be opened.

(2) The saving of all indexing, where, as in most commercial houses, an alphabetical order of accounts is desired. (This certainly applies to an Agents' Ledger.)

Not only is the time saved formerly spent in making and keeping up an Index, but the thousands of moments spent in using (referring to) an index are all saved, since, owing to the ready maintenance of perfect alphabetical order in the Cards, the account card itself is more easily found than a name and folio in an index.

(3) A saving of time spent in opening new Ledgers.

A Card Ledger is always new.

When the more active account has filled both sides of its card, it is carried to a new card, inserted in place of the old card which is retired, its serial relation to its more sluggish neighbours being in no wise disturbed thereby.

(I am inclined to think that the accounts would be in a more convenient form if only written on one side of the Cards. Also that a card could only be taken out and put away at the end of the year, with the sanction of the Auditor. However, these are mere matters of detail.)

(4) It enables you to group and classify your accounts to suit the special needs of your business.

(The system would be very convenient when, for instance, an Agent is transferred from one district to another, or under certain circumstances from one Branch to another.)

"Invalid" Accounts, for instance, requiring unusual vigilance, can be placed in a separate group—a hospital, as it were—where they can more easily be given daily attention until fully convalescent.

Or city and country accounts may be separated each in its own alphabetical order.

Other classifications will readily suggest themselves which need not be enumerated here.

(5) It enables you to apportion the Accounts among a number of Book-keepers (or Auditor's clerks) when a balance is to be rendered at a short notice (or an Audit carried out quickly).

(6) It is much less trying to the eyes to look at a given number of open card accounts of which each successively faces you on the same spot, than to hunt for the same accounts in a bound Ledger, right and left, now up and down, through an accumulation of dead matter.

To these one might add—

(7) It saves time and trouble in pulling about heavy books.

(8) It prevents accounts being carried forward (or backwards) to odd spaces in a crowded book. And it prevents an open account being overlooked in a crowded or untidy book.

The Audit of a Card Ledger.

73. On the other hand, the initial difficulty in using a Ledger, or rather, the principal objection to using a Ledger, the sheets of which are separate, is that the Auditor would refuse to audit a Ledger where he thought Accounts could be removed without his knowledge. Another objection is that there might be a fear that an Account could be taken out by a member of the Staff and be mislaid or lost. Now, the way I consider that these objections could be overcome is to arrange and number the folios as follows. We will first take the Agents' Ledger. Each Agent will be given a sheet, or if he is an important Agent, two or three sheets of a thin book, the size of a card. These sheets are then arranged according to the alphabetical order of Districts and of Agents' names. A few spare sheets are put in between, and then the whole lot are numbered.

At the top of each, near the number and above the name, there are two spaces marked:—Sheets added, Sheets removed—Reason, thus:—

4. LEDGER CARD.

45 Isaac Smith.

EDINBURGH

BROWN, GEORGE

JOINER

47 WEST STREET

Appointed 3 *June* 1894

Sheets added.		Sheets removed.		Reason.
345*a*	Brown, Gordon, I.S.	345*b*	Brown, Henry, I.S. (ruled out)	Dead
345*b*	Brown, Henry, I.S. (ruled out)			

Now the history of this sheet is that after Sheet 345, on which George Brown's Account was given, the next one originally was 346, Brown, James. Shortly after the Ledger was started a new Agent, Gordon Brown, was appointed. He was allotted a sheet which was numbered 345 A. After him another Agent was appointed called Henry Brown, so he was given a sheet numbered 345 B. He, however, died.

NOTE.—In the event of Henry having been appointed before Gordon Brown, as the strict alphabetical order of the cards is always kept, 345*b* would come before 345*a*. There is no objection to this as regards posting, as the items are posted to the names of the Accounts direct, not to the Ledger folios by means of an Index. The Ledger folios would be given in the reference columns of the Journals or subsidiary books, mostly to show that the postings had been made.

The Auditor's staff, however, might grumble at having to use the names of the Accounts when they were checking the posting of the Ledger from the Journals, but they could get over this by checking the Ledger, account by account, into the Journals.

75. You will observe that the Auditor's name, Isaac Smith, is signed on the top of the Sheet, say in red ink, and that he has

initialed all the markings to the effect that other sheets have been added or removed. If he does this before he begins his audit, taking notice that all alterations made since he last audited the Sheets are in order, and then again, when he audits the Ledger, if he sees that he does not audit any sheet not signed by him, I do not think the Staff could take advantage of him by juggling the Sheets in any way.

76. Although it is obvious that a Card Ledger would be very convenient for Agents' Accounts, such a ledger would also be more convenient, I think, for ordinary Accounts than an ordinary Book Ledger. You will have noticed that I advocated the use of several Premium Accounts. Now, this would probably be troublesome in a Book Ledger, but I do not think it would be so much so in a Card Ledger, which would be manipulated as follows. Each Premium Account would be on a separate Card (or set of Cards bound into a thin book). When a clerk wanted to post Premiums from, say, the Renewal Premium Debit Journal, which he would do once a month, he would take out the Cards for the Premium Accounts and make one Credit entry on each direct without using a General Journal, as is usually done. At the same moment another clerk might be posting, say, Expenses from, say, the Cash Book on to another set of Cards in the same Ledger.

77. Again, suppose some one in authority wants to study, say, an Expense Account, he can take out the card on which that Account is given. He can also get the corresponding card for the previous year, or, for that matter, the cards for the last five years. He can monopolise these cards for a week if he likes without causing those who use the Ledger for other purposes any inconvenience. In the event of his wishing to know the particulars of the items posted from a subsidiary book, he can take the card which will give him the reference numbers in his hand and walk over to that subsidiary book and look up what he wants. When ordinary book Ledgers are used, he would have in the first place to carry a heavy ledger to a bulky general Journal, which would refer him to the subsidiary book. All the time he was studying that one Account, he would monopolise two important books and the subsidiary book, the latter for a longer time than if he could refer to it direct from a card.

NOTE.—In the event of an Outlays' Cash Book, as suggested in § 59, being used, the particulars of the Expense Accounts would not appear in the Ledger. The totals from the Outlays' Cash Book could be posted quarterly, or even yearly.

Again, supposing you wanted to check the posting of the Ledger, you could take cards for, say, twelve different Accounts and spread

them out before three clerks, and post a subsidiary book on to them as quickly as you could read. You cannot open a Book Ledger at more than one account at a time.

78. COPY POLICY BOOK.

(*Right page, front.*)

Policy (*Number*) (*Class, etc.*)	Altered (*dates here*)	Life (*Surname*)

Copy Policy. (The illustration usually put at the top of policies would not appear. This, especially when the formal printing is compressed, will enable the Copy Policy to take up much less room than the original.)

INDORSEMENTS.

(*At top of left-hand page.* i.e. *back of sheet.*)

Number Life (*Surname*)

Date of Notice.	Assigned by	Assigned to	Nature of Deed	Date of Deed	Notice received from

(*Lower half of page blank.*)

Between every third sheet a slip would be inserted to keep the book in shape in the event of any extra pages or slips being pasted in.

NOTE.—As a rule Insurance Offices have very bulky Copy Policy Books. Some bind up Copy Policies as large as the originals. In one Office, whose books I have seen, the copies are printed smaller than the originals, but two or three are put on one page for the sake of compactness, but the books are very cumbersome. My idea is to make the Copy Policy Book the principal Register of the Policies, but to have it bound in many small and handy volumes.

REGISTER OF ASSIGNMENTS.

79. There are two or three methods of registering Assignments. But it must always be borne in mind that the simplest and easiest methods are not necessarily the most desirable. The principal object of a register of this kind is, or should be, to make it impossible for any dealings with the Policy of which the Office has had notice either directly or indirectly to be overlooked.

Copy Policy Book as Assignment Register.

80. (1) The safest method is to register all notices on the back of, below, or opposite, the Policies in the Copy Policy Book, which can easily be arranged for the purpose. In this way all dealings with the Policy and alterations by Indorsation, or otherwise, can be kept together, and the state of the Policy at any date seen at a glance. For sheet of Copy Policy Book, § 78, on previous page.

Assignment Register on Cards.

(2) Perhaps a handier method, though not such a safe one, is to have a Card Register of Assignments—a card being written for a Policy as soon as a Notice has been received, and a second Notice, if received, being written on the same card. These Cards would always be kept in the numerical order of the Policies. But, even if the ordinary Policy Register is marked that such an Assignment Card has been written, it would be extremely awkward if the Card got mislaid or lost.

Assignment Register in Ordinary Books.

(3) A third method, which I am inclined to think is neither convenient nor quite safe, is to record the notices of Assignment in a book Register according to date, and mark the Policy Register that this has been done with a reference number. This method is not safe, as it is a comparatively easy matter to put the reference number opposite the wrong Policy in the Policy Register. And it is inconvenient, when a Policy has changed hands more than once, to have to look in several places in the Register (or Registers) of Assignment for the different notices which have been recorded. It may be said that a clerk is just as likely to record a Notice of Assignment on the wrong copy policy as to put a reference number opposite the wrong policy in the Policy Register. This may be so; but when the Copy Policies are used in the method suggested, or a card Register of Assignments used, the Policy Register may be also marked that the Policy has been dealt with; so that if a rule is made (and also kept) that no claim should be paid or surrender value granted without the title to the Policy

appearing clear in both the Policy Register and Register of Assignments, there can be very little risk indeed of the money going to the wrong parties, on account of a Notice being recorded against the wrong Policy. Put shortly, the principle on which I consider a Register of Notices, etc., should be kept is, that the Records of such notices should be registered in the numerical order of the Policies.

81. With regard to the all-important rule that everything done of any importance in an Insurance office should be done in the first place by a junior and afterwards checked by a senior clerk or an official, one cannot rely on the rule being always kept. In drawing up a system, therefore, of Book-keeping, Registration, or anything else, you cannot be sure that work, which should be done by two men, will not be altogether done by one clever man, who "checks himself."

THE SUMMATION OF FIGURES TAKEN FROM CARD REGISTERS, CARD LEDGERS, ETC.

82. As before remarked, information recorded on Cards is always in a much handier form than the same recorded in the columns of a book, if it is ever required to rearrange the order of the information.

The use of a Summation Machine.

The usual way to sum figures taken from the Cards would be to write them in lists and then sum them. But it must be obvious to any of you who have ever seen a summation machine in use, that one which prints the figures summed besides summing them could be made of great use when Cards are to be listed. I have seen lists of cheques made up by bankers with such a machine in America. As the machine prints off the list of figures summed, to check the work done all that would be necessary would be to read off the Cards a second time with the list printed, or better, to read the list off on to the Cards. In this way I think it would be quite possible to shorten the mechanical work in a valuation, arranged on Mr. Chatham's Registers, by the use of Cards in conjunction with a Summation Machine. The first step would be to sort the Cards into the groups desired, the second to read off, say, the Sums Assured, then the Premiums Due, and portions not Due, and so on, to a clerk working the Machine. Totals only would be recorded. No pack of Cards would be gone back upon once it was summed, but totals would be revised by means of Alteration Cards, when alterations affecting any of the figures were made during the process of the valuation. In the event of the Valua-

tion being continuous, the Cards dealt with would mostly be Alteration Cards.

Annual Valuations.

83. Personally I would like to have a Card made for every Policy issued, on which would be recorded the Value of the Policy at the end of each year for, say, six or seven years. And if these Cards were divided into Branches, even without a Summation Machine, an exact Profit and Loss Account could be made for each Branch every year. If the Sums Assured and Premiums were valued separately on the Cards they could also serve for the Government Returns. But even if Net Policy Values only were recorded, I am sure they would repay the trouble taken in their construction.

84. As regards Accounting, a Summation Machine, of course, would be very useful for making the Trial Balance of a Card Ledger, or, for that matter, of any Ledger. It is for this, I understand, they are usually sold.

THE PREMIUMS-IN-ARREAR DIFFICULTY.

85. To all those, who have ever had any experience with Life Office Accounts, the great difficulty of being able to feel sure that Premiums, which are said to be in arrear, are really so, must be well known. I therefore give a special chapter to this subject. To keep a proper check as regards the Agents and their Arrears does not appear to me to be possible. There is no doubt that many Agents not only do not remit Premiums to the Office till some time after they have received them (which, to a certain extent, they must be allowed to do), but also sometimes spend the money they receive for such Premiums, and make up the balances of their Accounts with Premiums coming in at later dates. As Agents, however, are customers, the Office cannot, except under special circumstances, put, what an Auditor would consider satisfactory restrictions, on them. With those in the employment of the Office, however, it is different, and yet it is by no means a simple matter to devise any arrangement of checks which can be relied upon half as much as their honesty.

However, in the books I have suggested I would propose the following checks :—

Premium Receipts.

86. The Assistant Cashier would keep the Head Office Collection Book. The Cashier, who himself would have to sign the Receipts

(and this would be printed on them), would keep them locked up if signed before their due date. On a sum being paid, the Assistant would enter it in the Collection Book and the Cashier would initial the entry. The Cashier would not be allowed to make entries in the Collection Book himself. The Assistant (or the clerk acting for him) would not make the entry unless the Receipt passed through his hands. Besides, to make sure that the Receipt went out when the entry was made, a press-copy of it might be taken in a book kept for the purpose. It might be contended that the Assistant should sign the Receipt as well as the Cashier, to show that it had passed through his hands and to prevent the Cashier writing and giving a duplicate; but, if the latter did this, he would have difficulty in getting the Assistant to make the entry, on the production of the original Receipt at a later date.

Improper use of blank forms.

If, however, every Receipt had to be signed by an Official, and also to be press-copied when given out, I think it would be fairly safe for one man to keep them, receive the Collections, and make the entries. This then is an alternative arrangement for Head Office, and the arrangement I advocate for the Branches. The reason, that at Head Office some one besides the Cashier, in the event of his collecting without a clerk, should sign the receipts, is that otherwise he might easily, by filling in a blank, give a duplicate for a Premium received and keep the money till he felt inclined to repay it, which he could do by handing over the original receipt to be press-copied, and at the same time making the entry in the Cash-book. However, in the case of Branches, it would not be necessary for, say, a Head Office Official to sign the Premium Receipts if the Branch were given no blank forms. In a small Branch Office every press-copy might be marked by a Branch clerk other than the one acting as cashier, that the Receipt had been pressed in its correct order and at the date indicated.

The printed matter of Receipts which had to be press-copied would be in ink which would press-copy along with the writing of the Cashier.

The Receipt press-copy book would be supplied by Head Office, and would be sent to Head Office once a month with the Cash Statement, with which it would be checked.

RECEIPTS FOR REMITTANCES.

87. Besides the Premium Receipts, the Cashier can have books similar to cheque-books for Agents' Remittances, etc. Every form and counterfoil would be numbered, and the Receipt press-copied

when given. The Head Office Book-keepers would check the press-copies with the counterfoils and also with the Cash-book, so that, provided only that the payer demanded a Receipt on a proper form, the Cashier could not possibly delay to debit himself with money received. This system I also suggest for Head Office, even if the Assistant Cashier keeps the Collection Book, as mentioned above.

Checking Branch Receipts.

88. Referring again to the system of checking Branch Accounts in § 55, you will see that from the copy Branch Debit Sheets, the Combination Cash-book, and the analysis of the Balance of the account "Agents" the Head Office Book-keepers can easily see that every Premium is accounted for. A friend of mine, who audits, among various other kinds of Accounts, Life Office Accounts, and to whom I have shown this paper, has suggested that it would be better to have separate columns for Agents in the Branch Combination Cash-book. My only reasons for not having them are that the book has a great many columns already, and that transfers between what would then be the General Branch Account and the Agents' Account would take up a good deal of space on the pages, and increase the number of journal entries in what is primarily a Cash-book. The object of having a General Branch Account separate from the Agents' Account in the Cash Book columns is that an Auditor or Inspector can come in on the Branch at any moment and ask the Cashier to reconcile the Balance on the former account with the Receipts in hand. This could not be so thoroughly done if the General Branch Account or Branch Cashier's Agency Account is kept, as I suggest in § 45, along with the Agents' Accounts in the Agents' Ledger, as a Ledger account probably would not be always up to date like an account shown in the columns of the Cash Book. However, with a thorough periodical check at Head Office, and the arrangement, which I suggest of press-copying the Receipts, I do not see that a Cashier could either purposely or inadvertently do what he should not do without being detected.

89. NOTE.—I have been advised, for obvious reasons, not to explain elaborately why certain checks should or need not be used as regards Receipts and Receipt Forms. I recommend, however, the following checks in addition to those suggested above :—

1. On all Receipt Forms it should be printed that no Receipt should be taken
   (*a*) Unless written on the Official Form ; or,
   (*b*) If either the date or the sum is corrected or altered in any way.
2. All Notices of Lapse or Non-Forfeitable Debt, in the event of a Premium not being paid, should, if possible, be sent direct by Head Office to the Assuree. (*See also* § 38,—Addresses.)

90. Although this system of press-copying all receipts is a simple check, I have written about it at some length because I would like to prove that it would not only work automatically but also, what is as important, appear perfect to those whom it was meant to check. It is not that I think Life Office Cashiers require more checking, or, for that matter, as much checking as other people.

INVESTMENTS.

91. The following method of registering Investments and of charging the staff with Interest, Dividends, etc., receivable, as they fall due, may be found convenient in a large Office.

On an Investment being made or a Loan (other than a Policy Loan) being granted, the transaction may be entered in order of date in a Memorandum-book with the following headings:—

INVESTMENT MADE MEMORANDUM-BOOK.

Date authorised by Directors.
Amount. (Face Value.)
NAME (*or Borrower*).
Date of Deed.
Solicitor.
NUMBER.
Price.
Date paid.
If added to card of previous Investment,
number of that card.
Date card removed from Investment Register.

The entries will be made in the book in order of date, and, as the numbers given will afterwards be the Investment or Bond numbers, the Memorandum-book will form a Register in numerical order of the names of the Investments, for which there should be Register Cards.

THE INVESTMENT REGISTER.

92. The Investment Register proper will be on cards. Different classes of Investments can have different colours. It would probably be considered desirable to alter the wording on the cards to suit the requirements of the different classes. I do not, however, think it necessary to print here, say, five or six different designs for these classes, but I suggest that the form and wording of the cards should be in all cases somewhat as follows:—

INVESTMENT REGISTER CARD.

Borrower (*or Investment*) (*Class in Balance-Sheet*)

No.....

Loan, £..... advanced on..... Duration of Loan.....
(*or price*)

Principal Repayable in Instalments of.....

Interest Rate in Bond..... Date of Deed.....
(*or certificate*)

Rate to be Charged..... ... Payable..... ..... Date of Recording .....

SECURITY

(*Trustees, Solicitors, etc.*)

Solicitor or Address, etc.	Date.	Cash-Book Folio.	Cash Value Sum Altered.	Face Value.			Total Annu Nominal Interest.
				Amount and Additions.	Repaid.	Balance.	

These cards would be kept in the classes in which they appear in the Balance-Sheet, and would be arranged in each class in alphabetical order. The card would be fairly large and long-shaped, in order that all the important information could appear on the front.

On the back of the card can be given any further information, which may be found desirable, such as an Index to the letters written and received in connection with the Investment.

The Repaid column would only be for Instalments repaid by ıe Borrower or the face value of portions of Investment sold. 'he Amount and Addition column would be for the amount of ıe Loan, or the face value of the Investment, in the first place, nd afterwards for additional sums lent to the Borrower, or ıcreases made in the face value of the Investment.

93. The true Interest and the true value of an Investment ould be got from the Interest Debit Card. This is the general rm of the card I suggest—

INTEREST DEBIT CARD.

(*Branch*)

rower
Investment)

.....

ninal Amount £.....

ce.....£.....

n Recoverable at..... .....

n to be provided for £.....

Nominal rate of Interest.....

True rate of Interest.....

Amount Nominal Yearly Int. £.....

Amount Do. for half year £.....

Duration of Loan
(*or Investment*).....

Cash Fol. if Recd.	True Interest.	Capital Repaid.	Capital Outstanding.	Ledger Fol.	Income Tax.

ctual card would have *two sets of* columns with their respective headings, or it *longer in shape. The columns* would also be continued on the back.

Now this card is suitable for any ordinary Investment. It is, however, not meant for Policy Loans, which are recorded on the Copy Policies, § 78, the Interest receivable thereon being charged by means of the Renewal Premium Debit Cards, § 31.

The use of the columns on the Interest Debit Cards.

94. In the case of Loans on Personal Security and Mortgages the True Interest will be the Nominal Interest, but the Capital Repaid Columns may be used for Instalments repaid by the Borrower if thought desirable. Mortgages, however, which have been bought at a premium or a discount, will be in the same position as Debentures or Stocks redeemable. In these cases the Income Tax in the Income Tax column will be for the Income Tax on the Nominal Interest, not the theoretically equitable Income Tax. In the case of Rent Charges, however, the Income Tax will be the equitable Income Tax. There will of course be no Sum Recoverable in the case of Rent Charges, but the total price will have to be provided for out of the Instalments of Capital Repaid. In the case of Feu-Duties and other Perpetuities, the Capital Repaid column will not be used.

The Ledger folio column is for the posting of the sum, which is theoretically repaid in the Instalments of Nominal Interest, to the credit of the class of Investments, to which the Investment recorded on the card belongs. A new Card will generally have to be written if the Amount of the Investment is altered. This will not be necessary so often in the case of the Register Cards, § 92.

The Interest Debit Cards are arranged according to the dates in which the Interest is payable.

The few yearly Cards and those for quarterly Debits will be kept separate: these will be blue and red, the latter being divided into three sections of four months each.

The half-yearly Cards will be white, and divided into six divisions of two months, so that those on which Interest is payable during June and December will be together.

Interest Debit Sheets for Cashier.

95. From these cards Receipts will be written for Interest, when necessary, and a Debit Sheet will be made up for the Cashier once a month.

The total of these sheets will be debited to "Cashier's Interest" (or a Branch) at the beginning of the month and credited to Interest Receivable. When received, the Cashier will Debit Cash and Income Tax and credit "Cashier's Interest" per his Interest and Income Tax columns (*see* § 57). At the same time the total of the Nominal Interest will be debited to Interest

Receivable and credited to Interest Account and the Investment Accounts with the respective amounts of True Interest and Capital Repaid contained in the Nominal Interest.

In the event of there being Investment Columns in the Cash Book, as suggested in § 57, the Capital Repaid (or, as perhaps it might be more correctly called, the Capital written down) will either be posted to separate Investment Accounts in the Ledger, or recorded in inner columns in the Investment Accounts. The object of doing this is that the Investment Columns in the Cash Book can be readily balanced with the Investment Accounts in the Ledger.

NOTE.—The debit sheet of one month should be compared, item with item, with the debit sheet of the same month of the previous year. A Reconciliation should be made up of the differences, and each marked with the page in the (Directors') Business Book which instructs the alteration, or some other explanation written opposite it.

The Auditor may either check the Reconciliations, or satisfy himself that the staff of the Office make them. He can, however, check the receipts from Interest and Dividends otherwise as explained below in § 97. If there are many alterations, "On" and "Off" cards, see § 32, can be kept in the drawers along with the Debit Cards as an aid to the clerks when making the Reconciliations.

Cards suitable for the Investment of other Companies.

96. This arrangement of cards for Investments Registers could be used by Banks, Reversionary and Investment Companies, as well as Insurance Offices.

You will notice that I assume that the Nominal Interest of or, speaking generally, Nominal Income, from all Investments is divided into Capital Repaid and True Interest. If this is not always done, I am sure, in an Insurance Office at least, it ought to be. The rough-and-ready way of dividing the sum to be provided for into equal portions, the number of such portions corresponding with the number of instalments of Nominal Interest, in the long-run is not really a convenience. The correct instalments of Capital in all cases can be easily calculated with a table of Logarithms or, better, an Arithmometer.

AUDIT OF THE INVESTMENTS.

97. As the Audit of the Investments made, the Securities and the Interest and Dividends received, is a very important, perhaps the most important, part of the Audit of the Accounts, etc., of a Life Office, or, for that matter, of any Company or Trust which has to be audited, I will explain briefly how the Investments and Income therefrom, recorded as I suggest, can be satisfactorily audited. This can be done without the Auditor really depending on the cards, as follows:—

A list is made up of the Securities, of which a summary will be afterwards published in the regulation Balance-Sheet.

This will be made in the form of a many-columned statement. This Statement will be compared with that of the previous year.

Amounts.

A Reconciliation will be made in classes of the Face Values of the Investments, and also of their values (before being "written down," as explained below). The page of the Business Book will be given opposite each alteration. The Auditor will see that the alterations have been authorised by the Directors in the Business Book, that the Directors have acted within their powers, and that all their instructions have been carried out.

Interest, etc.

An Interest-received column will also be given on this Statement, by which the Auditor will see that the correct amount of Interest has been received. That it is debited in the Books on the date it should have been received he can check by the Interest Column in the many-columned Cash Journal, § 57. He should also see that all Interest Receivable is mentioned either in the Cash Journal or otherwise accounted for.

As mentioned above (§ 95, Note), he can also check the monthly Interest Debit Sheets, should he think fit.

Securities.

98. He will then see that there are Securities for each Investment in the Statement, in the usual way, and he can, at the same time, if he has several clerks, or later, see that there is an Investment Register Card for each Investment in the Statement, though it is not absolutely essential for him to check them. He can very easily do it, however, as the Register Cards are kept in the order in which the Investments are given in the Statement, the Statement having been made up from them in the first place.

Values written down.

99. Besides the above columns in the Statement, there will be given a "Written Down Value Column."

The Auditor can always see at a glance, as the Face Value is given on the Statement, when the price of any Investment which has been bought at a Premium must be written down each year. He can check the amount written down by looking at the Interest Debit Card, on which it is recorded as "Capital Repaid" in the Instalments of Nominal Interest, or he may satisfy himself that the sum written down is correct enough for auditing purposes, by seeing what was written down at the end of the previous year, or,

best of all, he can check it for himself in an Actuarial manner. He will then see that the totals in the Written Down Value Column agree with the totals in the Investment Accounts in the Ledger.

LETTER-BOOK INDEX.

100. It will be found a great convenience to have Letter-book Index Cards. The ordinary method of having the Index in the letter-book means that the Indices of several letter-books have often to be searched, in order to find a letter. The operation is more tedious when, as often happens in letter-books for the correspondence with Branches, there is no Index. This form of card, which is almost identical with that used by the Northwestern Mutual Life Insurance Company of Milwaukee (*see* § 21), will, I think, be found very convenient.

LETTER INDEX CARD

Policy (*or Bond*) Number (*Name*)

Letter Book.	Page.	Letter Book.	Page.	Letter Book.	Page.

The name can be that of any tradesman or newspaper, with whom the Office corresponds, as well as that of a Life Assured or Borrower.

This card can be also arranged for the indexing of the files, etc., in which letters received are put away. Columns for this purpose might be put on the back. However, all letters received connected with a Policy (other than notes from Branches) should be filed together in such a manner that indexing is unnecessary.

THE SYSTEM OF THE PRUDENTIAL INSURANCE COMPANY.

101. After I had written the greater part of this paper, I decided to request the Managers of the Prudential Insurance Company to allow me to see the system of accounting at their Head Office in London, as I understood they made much use of cards. These gentlemen most kindly allowed me to do this, giving me every facility to study the arrangements of their great organisation.

The book-keeping system of the Company, for obvious reasons, differs somewhat from either that of American or Edinburgh Life Offices, but what I was able to see in the short time I was in their wonderful building was very interesting and most instructive. This is a short description of the general principles on which they keep their Accounts.

All Books and Papers are first of all divided into twelve districts. The Industrial Business and the Ordinary Business are separated, but run, as it were, on parallel lines right through the Accounts. The twelve Districts are referred to as A B C D, and so on, and all Agents' sheets, envelopes, etc., are marked with one of these letters.

The ordinary Prudential Agent is furnished with Account forms, on which he fills in his transactions. There are spaces, in which he records both his Industrial and Ordinary Business. He has to send one of these forms once a week to the Office.

(1) Debits to Agents on Account of Industrial Business.

Book Registers are kept of all Proposals accepted. The books are in the twelve District Divisions. The Proposals are recorded in them in numerical order, and the Policies when issued are given the same numbers.

In the Registration Department the Policies are also registered in separate books. A book represents an Agency. The Agent keeps a similar book. To enable him to keep his Register correct, a slip is sent to him, on which is given his new Policies, and the total of his weekly premiums brought forward.

Agents have also Lapsed Policy Registers. The total of Lapsed Policies is brought forward in a similar manner to the total of Policies added. The difference of these totals gives his weekly collectable debit. Policies revived are added to new Business.

The Agent is not given any Receipts, but the Policyholder keeps a book, in which the former acknowledges receipt of Premiums when he calls and gets them.

(2) Debits to Agents on Account of Ordinary Life Business.

Renewal Registers are kept for these, which are divided into the twelve District Divisions. Yearly Registers are again divided into months, Half-yearly into six sections of two months. Separate quarterly books are kept for each set of four months.

The Policies are recorded in the Renewal Registers in Numerical order. The Receipts and Renewal Notices are written by the clerks in that order, called over together into the Register, and then re-arranged into Agencies. Renewal Debit Lists are then written for each Agent.

Before the Debit Lists go out they pass through the Audit Department, and are recorded in the Auditors' Renewal Registers. Afterwards, in order to see that the Agent accounts for the Premiums, etc., with which he is debited, his weekly Account sheet, when sent in, is also checked with the Auditors' Renewal Registers.

Note.—For the benefit of my professional brethren, I may mention that the Prudential Company use the words "Audit" and "Auditing" almost as freely as Americans. They have an "Audit Department" for checking Agents' Sheets, etc. The Directors have a separate and very excellent system on which they "audit," or rather supervise, the cash transactions; and, besides, there is an audit, in the technical sense of the word, by a firm of independent experts.

(*Auditors'*) *Renewal Register.*

102. The Registers are divided into Agencies. Premiums are entered in their numerical order in each Agency. The book is cross-ruled. Besides one Premium column there are perpendicular rulings for the twelve months, and horizontal rulings for five years. In one of the little oblongs formed by these rulings is entered the number of the weekly sheet, in which the Agent accounts for the Premium due. In this way the Auditors know weekly what the Company get, and what is outstanding.

Outstanding Receipts are returned at the end of the month. Agents cannot collect without giving an Official Receipt.

The Accounts of Solicitor correspondents and other such Agents are checked in a similar manner. The Premiums with which they are charged, however, are registered along with those paid direct to Head Office.

Cash Collection Books.

103. In no way, perhaps, can the huge number of transactions which daily pass through the books of the Prudential be realised

as readily as by simply counting their Cash Books. Confining our attention to Collection Books only, there are 216 of these in use at Head Office. This number is made up as follows:—For the first three days of the week there are three books for each District, and for Thursdays, Fridays, and Saturdays six books. As there are double sets, one set being in use while the other is being audited, the number becomes eighteen, and, as there are separate sets for the twelve Districts, the total number is 216.

In all these Collection Books Ordinary Business is put in a separate column. These books are then rewritten into 72 Journals, so that the items may be divided into Superintendencies, and from these Journals they are posted to the Agents' Ledgers.

Agents' Ledgers.

104. The system in which the Prudential keep their Agents' Accounts, I think, is almost unique. I have given the above particulars at some length in order to lead up to the Agents' Ledgers in a satisfactory manner. The Ledgers are all many-columned. They have different columns for different kinds of Receipts and Credits. There is no "Entry Column," as the heading of the column explains each item. There is one Total Column in the centre, a Debit and a Credit Error brought forward Column, a Column for the Debit Balance brought forward, and by these means a Net Balance Column, as in a Banker's Ledger.

The entries are made in the Ledgers direct from the Agents' Sheets after they come from the Audit Department, § 101 (2), and, in the event of the Cash Column in the Agent's Account being wrongly posted from the Journals mentioned above, the Balance in the Agents' Balance Column would not agree with the Balance shown on the Agent's Sheet.

The Agents' Ledger Accounts are summarised, columns being kept separate, into Superintendencies, and finally into a General Abstract once a Quarter. The totals in this General Abstract give the Premium Income for different classes of Premiums, Commission, and Agents' Expenses for the Company during the Quarter, and the total of Agents' Balances at the end.

The Card System compared with the Prudential System.

105. Now comparing the system I suggest with the system adopted by the Prudential of keeping the Agents' Premium, etc. Accounts, you will have noticed in §§ 101 (2) and 102, that they do not keep their Renewal Registers on cards; but, if the card

system of Accounting would be a convenience for an ordinary British Office, I do not hesitate to say that it would be a far greater convenience for the Prudential.

Desirable arrangements in the Prudential System can be readily introduced into the Card System.

106. I also prefer the Edinburgh arrangement of Premium Charge Reconciliations, which I think can be conveniently brought about by the use of "On" and "Off" cards, see § 69, to the method of Auditing the Premiums debited to Agents.

But, on the other hand, their Agents' Ledger Accounts are more thorough than anything I have seen of the kind. A many-columned system of Agents' Accounts is by no means antagonistic to my system, rather otherwise. The only modification necessary is to post the sums (which consist of the totals of the columns of the Agents' Sheets) in the subsidiary columns in the Agents' Renewal Debit Journal, § 36, Sundry Debit Journal, § 56, and the Agents' Credit Journal, § 51, Branch Renewal Debit Sheets, § 36, and Branch Cancellation (or Credit) Sheets, § 51, to the Agents' Ledger Accounts instead of the net sums as proposed in § 49.

107. I would not, however, dispense with the use of my many-columned Journals, because, though theoretically with many-columned Branch and Agents' Sheets and also many-columned Agents' Ledger Accounts they would be unnecessary, they would constitute an excellent check.

I may mention that if the Agents' Sheets (§§ 41 and 40), which I propose, are all carefully filed in Agencies (as they ought to be), any one can get from them a thorough knowledge of an Agent's transactions, almost as easily as from a many-columned Agents' Ledger. They would also be handier in some respects than Accounts kept in book Ledgers.

Principal Difference between Edinburgh and Prudential Systems.

108. The greatest theoretical difference between the Prudential system and the Edinburgh system is perhaps the method the Prudential have of finding their Premium Revenue by means of their Agents' Ledger, after the Premiums are accounted for. In the Edinburgh system the Premium Revenue is got by charging Agents with what they are expected to collect, and afterwards crediting them with what they do not receive. The Prudential method is, no doubt, the better of the two for Industrial Business.

CONCLUSION.

109. Those, Gentlemen, are the suggestions which I make in regard to Life Office Accounting. They include a system of Registration by cards; and, as the explanation of this system forms the greater and the more important part of my paper, I will take the opportunity of saying a few words in conclusion on the use of cards.

General Remarks on the Use of Cards.

Cards are practical.

110. It may be contended that my suggestions are really theoretical, and not practical, but you must remember that the Americans, who are a more practical nation than we, *often* use cards where we *always* use books.

They do not get lost.

111. Again, it may be said that cards would get mislaid and lost in a large office. But surely if Actuarial cards can be used by a large office, such as the Prudential, where, at the annual division of profits, they are distributed among various departments, bookkeepers could use cards for Accounting without difficulty. Besides, if Americans can keep cards without either losing or misplacing them, Englishmen and Scotsmen could also learn to do so.

112. To prevent cards being mislaid :—

(1). They can be pierced with a rod and locked into the drawers in which they are kept.

(2). The top of the Cabinet of drawers, in which the cards are kept, can be made in the form of a desk or table, on which they can be examined and marked without being taken away.

All Cabinets of drawers, it may be mentioned, would be made castors or wheels, so that they could be easily run into safes at night.

(3). If cards are taken away from the drawers, the clerks, who work with them, would always have trays or open boxes on their desks in which to keep and carry them.

113. Important Ledger Accounts, such as "Premiums," need not be on cards, in the event of a Card Ledger being used. These accounts can be kept in separate thin books (see also § 76) in which state they are, in some cases, even handier than on single cards.

114. As regards the Records of Policies, you will notice that the Copy-Policy Book, which I really make the principal Register of the Policies (§ 78), is not on cards, so that, if by any chance, either a Policy Register or a Renewal Premium Debit Card gets lost, a new card can be filled in from the Copy-Policy.

Again, if the Reconciliations I suggest (§§ 67, 95 Note, and 97) are made, it is not possible for cards to get lost without the Staff discovering their absence.

Difficult to handle at first.

115. Again, as to handling cards, there is no doubt that at first an ordinary clerk would be awkward with them, but he would soon learn to handle them expeditiously with a little practice. Just as even a clever man could not be expected to shuffle or deal a pack of playing-cards readily, on playing a game of cards for the first time, but if he kept on playing he would instinctively learn to manipulate them properly.

In a similar manner an ordinary British clerk would soon learn, with a little practice, to smartly pick the June Renewal Cards out of a December drawer.

Colouring and "tabs."

116. If there is any fear of a red card being mistaken for a white or green one, or *vice versâ*, they can have "tabs" as well as different colours. A "tab" is a nob or excrescence on the top edge of a card, on which, say, a date is written. The cards for each month, where "tabs" are used, would have the "tab" in a different position on the edge, so that if a May card were put among June cards, the tab of the former would not be in line with the tabs of the latter, and the mistake would be at once detected.

118. The Premium Renewal Debit Cards (§ 31) and the Interest Debit Cards (§ 93), which I suggest, might very well have tabs to indicate the month in which the Debits fall due: but to make cards with tabs is more troublesome and expensive than to make them in the ordinary way, as a set of dies are required for the purpose.

Going back on past transactions.

119. It may be said that items recorded on cards cannot be gone back upon in after years, as they could be, if recorded in books, as items in books are generally recorded in order of date. But—because cards can be arranged in any order—the fact of their not being kept in order of date is immaterial, as they can be easily rearranged in that order at any time.

They are never to be destroyed.

120. Of course it must be always remembered that, when a card, the information on which has become ancient history, is *put* away, it is not (or never should be) *thrown* away or destroyed.

Starting a Card System.

121. Again, nearly all Registers in book form must be re-written some day, and it is a far simpler matter to copy information in books on to cards than into other books, because the cards can be written in any order and at any odd time.

Cards useful in many other Offices besides Insurance Offices.

122. Although the Card System, which I have suggested, is arranged for Life Office Accounts, I would like to mention in closing a few of the many other circumstances in which Card Indices and Card Registers could be found of great service.

Librarians.

(1). Card Indices can be and are largely used in Libraries.

Advertisers.

(2). They could be (and probably are) used to advantage by Company Promoters and others who keep lists of "Investors."

Medical Men.

(3). Medical men could write short particulars of peculiar "cases," coming within their experience, on cards, and, if these cards were sent to a central bureau, where they could be sorted into classes, very useful information could be gathered about the most troublesome diseases.

Registrars.

(4). Cards also could be used by Registrars in the Registration of Conveyances and Mortgages. Where, for instance, subsidiary Abstracts of Deeds are recorded in Books, the names of *places* and the names of *parties* mentioned in the Abstracts have both to be separately indexed. But, if the Abstracts are recorded on Cards, all those bearing on one property can be kept together, the index of places can thereby be done away with, and the index of parties being also put on Cards, can be kept in exact alphabetical order, which is impossible in a book-index.

FINALLY.

123. Finally, Gentlemen, if in any of my suggestions I have overlooked any difficulty which might occur in practice, I must ask you not to condemn my system, or even that particular suggestion, but to point out my mistake in order that I may attempt either to overcome the difficulty, or to modify my suggestion accordingly.

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The Practical Calculation of Office Premiums

BY

HENRY MOIR, F.F.A.
OF THE SCOTTISH LIFE ASSURANCE COMPANY, LIMITED

The Practical Calculation of Office Premiums.[1]

THE ACTUARIAL SOCIETY OF EDINBURGH was formed more particularly for the benefit of students, to assist them in their studies of actuarial and mathematical subjects; and it is therefore unnecessary to make any apology for submitting a paper of an elementary character, which makes no pretence at originality of thought, but which is designed simply to bring together some of those practical questions which have been dealt with by Actuaries of ripe experience, and to place them before students in a compact form. Those questions which do not appear to have been discussed by others, are well known to Actuaries who have had any considerable experience in the practical calculation of office premiums; but yet the following notes may be of service to students who, in many cases, have little opportunity for gathering such information.

In order to deal clearly with the subject, it is desirable to state, in the first place, one or two of the fundamental principles which should regulate the calculation of office premiums. The premium payable by the policyholder forms the foundation upon which the whole structure of life assurance is built; and if the premiums be inadequate, as in the case of Assessment Companies, the structure must sooner or later collapse. It is sometimes urged that rates are fixed by competition, and no doubt this is a factor which must have some weight in their computation; but the premiums should on the average, and in all classes of assurance, be sufficient to meet the risk run and the expense incurred; while in proprietary Companies a further small addition should be made, to provide part of the dividend payable to shareholders in return for their guarantee of the Sums Assured.

The effects of medical or other selection should be kept in view, because it will be found that the rates of premium deduced from an aggregate table are too low for new entrants at young ages, and too high for those entering later in life. This will be

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[1] Read before the Actuarial Society of Edinburgh 3rd March 1898.

seen from the following comparison of Sprague's Select Premiums with those of the H^M Table:—

Age.	Value of 100 π_x @ 3½% Interest.	
	By Sprague's Select Tables.	By H^M Table.
20	£1 9 5	£1 6 7
30	1 16 3	1 15 5
40	2 9 6	2 9 4
45	2 19 6	2 19 8
50	3 12 4	3 13 4
60	5 13 8	5 17 0

According to an aggregate table a policyholder, entering at (say) age 40, is charged such a premium as will, on the average, exactly meet the sum assured at the death of each of a mixed body of lives, of whom some will have entered as healthy lives ten or twenty years ago, while others have still to enter at older ages. The deteriorated lives in the aggregate experience have the effect of increasing the premium required for the risk as compared with a select body of lives; but, on the other hand, the introduction of new healthy lives in the future has the opposite effect, reducing the average premium found necessary. These two forces therefore, acting in contrary directions, cause the premiums, calculated from an aggregate table, to fall short of or exceed the corresponding select premiums, according as the force governed by the admission of healthy lives in the future is stronger or weaker than that governed by the deteriorated lives already existing.

At the present time the Select Tables formed by Dr. Sprague, from the material collected by the Institute of Actuaries, are believed to be the most reliable for Life Office calculations. It is sufficient to calculate the premium for each fifth age only, and obtain the intermediate rates by interpolation.

The expenses incurred in connection with the issue of a policy and the collection of the relative premiums, usually depend, partly upon the amount of the policy, and partly upon the premium payable. Accordingly the loadings for expenses should, in general cases, include (1) a constant addition for each £100 assured, and (2) a percentage addition depending upon the premium payable. If a constant addition only were made use of, the loading to premiums at young ages would be too great when viewed in relation to the much larger premiums payable by older entrants; while if the net premiums were loaded with a percentage only, the resulting rates at young ages would be too small as compared with those at older ages. It may here be remarked that any office having unusually low rates at certain ages, or under certain classes

of assurance, will find that a larger proportion of business is likely to be transacted at these low rates—a result to be expected from the natural selection exercised by those effecting policies.

The rate of interest to be employed is also a most important factor in the calculations, and this is a subject upon which great diversity of opinion exists. It has been remarked that the rate of interest assumed should approach that which the Office may rely upon earning until the policy may become a claim; but this, which would necessitate calculations at perhaps $2\frac{1}{2}$ per cent. interest, is an extreme view to take; and it is much more reasonable to adopt a rate approaching that which the Office can at present realise, and to make allowance for possible reduction by introducing in the loading what may be called a "margin for fluctuation." The recent fall in the rate of interest may have been partially counterbalanced by a more favourable mortality experience than that on which existing Tables are based; and, judging from the present rates of interest earned by Offices, it would seem as if $3\frac{1}{2}$ per cent. were a fair rate to employ, or even the $3\frac{3}{4}$ per cent. suggested by Mr. Andras (*J. I. A.* xxxii. 343).

From the foregoing it will be seen that the elements in the computation of ordinary Office premiums are:—

(1) Rate of Mortality.
(2) Rate of Interest.
(3) Rate of Expense.
(4) Margin for possible fluctuations in these rates.

Whole Life Without Profits.

These elements are clearly brought out in the formula which we owe to Dr. Sprague, where the expense is met by (1) an initial commission of 1 per cent. on the sum assured, spread over life; (2) a constant of 2s. 6d. per cent. on the sum assured; and (3) a percentage ($7\frac{1}{2}$ per cent.) calculated on the pure premium plus the two constants, for renewal commission and fluctuations.

$$P_x = 1{\cdot}075\left(\pi_{[x]} + \frac{{\cdot}01}{a_{[x]}} + {\cdot}00125\right) \qquad (1)$$

(Dr. Sprague used 4 per cent. interest, and at this rate the formula may be written $1{\cdot}086\ \pi_{[x]} + {\cdot}00175$.)

This is a good practical formula for ordinary classes of business, notwithstanding the two finical objections in theory which have been raised, viz. (1) that the percentage addition should be made to the *gross* premium, so that, when $7\frac{1}{2}$ per cent. is deducted from the Office rate, the result will be the pure premium $\pi_{[x]}$ plus the constant loadings (*i.e.* $\div{\cdot}925$ instead of $\times 1{\cdot}075$); and (2) that $a_{[x]}$ should depend upon the combined rates of mortality and discontinuance, and not upon the rate of mortality only. The first

varies from 3d. to 6d. per cent., while the loss under the second is more than covered by the balance of the reserve value of the Policy, falling to the Office on surrender or lapse.

The general formula given by the late Mr. Rothery (*J. I. A.* xxx. 135), which may be included here for the sake of completeness, was constructed with the following loadings :—

(1) In respect of the first premium, £2 per cent. upon the sum assured and 5 per cent. upon the gross premium.
(2) In respect of each premium including the first, 8 per cent. upon the gross premium.
(On an average premium of £3 per cent. this amounts to 80 per cent. on the first premium and 8 per cent. on renewals.)

The formula after reduction is therefore :—

$$P_x = \frac{A_{[x]} + \cdot 02}{\cdot 92 a_{[x]} - \cdot 05} \qquad (2)$$

It will be observed that, as compared with Dr. Sprague's formula, the definite constant loadings are not present, but the percentages are increased considerably. This has had the effect of making the premiums in early years lower, and in later years higher, than those of Dr. Sprague; and accordingly the rates deduced by this formula are perhaps better for competitive purposes at the present time, because many of the rates still in use were based upon an aggregate Table of Mortality such as the H^M, where, as already explained, the premiums in the early years are too low. For a standard formula Dr. Sprague's would appear to be the better, as in the other the loadings depend too much upon the premium actually payable, and do not allow specifically for the constant expenses in the collection of premiums. Doubtless, however, the formula was found suitable to the individual case under consideration by Mr. Rothery; and it must be borne in mind that it was not put forward as a standard for comparison.

Half-Yearly and Quarterly.

When premiums are payable half-yearly or quarterly, a larger sum than the proportion of the annual premium must be charged to cover (1) Loss of Interest; (2) Possible Loss of Premium in the year of death; and (3) Additional Expense in collection. The addition to the pure premium for Loss of Interest and of Premium may be readily calculated (see Institute Text Book); and brings out an average of over 2 per cent. for half-yearly, and 3 per cent. for quarterly payments. The additions made in practice vary from 3 to 5 per cent. for half-yearly, and from 5 to 7½ per cent. for quarterly payments, so that the excess over the theoretic addition is available to meet the additional trouble and expense. Some Offices protect themselves against the loss of premium in the year

of death by charging an *annual premium payable by instalments*, stipulating that any unpaid instalments of the premium current in the year of death should be deducted from the Sum Assured. Any surcharge for additional expense in collection would appear to be unnecessary in the case of large policies.

Limited Payment and Ascending Scale Policies.

When the whole-life premiums have been definitely agreed upon, those for (1) Limited Payment and (2) Ascending Scale Policies may be at once derived from them by equating the payments, the benefit being in all three classes the same. Accordingly, if lP_x represent the Ascending Scale premium during the first five years (to be deduced as indicated on p. 277), and hP_x the premium thereafter, the equations may be expressed—

$$(1)\quad P_x\mathbf{a}_x = {}_nP_x\,{}_{|n}\mathbf{a}_x$$

$$\text{whence } {}_nP_x = \frac{P_x\mathbf{a}_x}{{}_{|n}\mathbf{a}_x} \qquad (3)$$

$$(2)\quad P_x\mathbf{a}_x = lP_x\mathbf{a}_x + (hP_x - lP_x)\,{}_{s|}\mathbf{a}_x$$

$$\text{whence } (hP_x - lP_x) = \frac{(P_x - lP_x)\mathbf{a}_x}{{}_{s|}\mathbf{a}_x} \qquad (4)$$

If the Whole Life premiums be calculated at $3\frac{1}{2}$ per cent. it would seem reasonable to obtain the Limited Payment (and more particularly Single Payment) premiums by the use of annuities at a slightly higher rate, say $3\frac{3}{4}$ per cent., or even 4 per cent., should the Office be able to realise this latter rate, because the expenses in collection of premiums, etc., are likely to be lighter.

The Office Premiums for Endowment Assurances, Joint Life and Last Survivor Assurances, etc., may be formed by self-evident modifications of the general formulas above given.

Short Term Assurances.

Term Policies should scarcely be passed over without some remark. Neither of the two formulas referred to can be properly applied to the calculation of such premiums, because it is not the general practice to pay a large initial commission on this class of business, although 10s. per cent. on the sum assured is sometimes paid. Even this modified sum must, however, be looked upon as extravagant, more particularly in the case of Policies for only one or three years' duration; and, in order that the premiums might bear so heavy a charge, it would be necessary to adopt such rates as would be practically useless in competition. The commission under this class being therefore limited to about 5 per cent. on the premiums paid, or even less, it would seem as if the rates should properly be calculated by adding simply a percentage and constant. Such loadings must, however, be considerably higher than the corresponding whole-life loadings for several reasons:—

(1) The business remains on the books of the Company for a

short term only, and the trouble and expense in connection with the issue of the Policy ought to be met out of the loadings received during that period; (2) the rates of mortality deduced by Dr. Sprague were obtained from an experience constructed according to calendar years, and, notwithstanding the ingenuity with which the calendar years were made to coincide with average Policy years, there is some doubt as to the mortality (especially during the period immediately following entry) being such as would actually be found to exist; (3) it is the opinion of many actuaries that mortality is considerably heavier in this class than in the ordinary classes of assurance from which existing Tables have been computed; and, until the new Institute Experience, relating exclusively to Term Assurances, is available, it is desirable to introduce a considerable 'margin for fluctuation.' On the other hand, it must be borne in mind that medical selection is now thought to be more efficient than in the days when the Policies in the present Institute Experience were effected, and this may have some effect upon the mortality, especially during the early years of assurance. There is much difficulty in giving any general formula applicable to Term Assurances, but it will be found that, bearing competition in view, the loadings can scarcely be more than a constant of 5s. per £100 assured, plus 10 per cent., modified for different terms, etc., as undernoted,

$$P^{1}_{x\,\overline{n}|}=\frac{1}{\cdot 90}\{\pi^{1}_{[x]\,\overline{n}|}+\cdot 0025\}. \qquad (5)$$

Another element which enters into the calculation of Short Term premiums for any term greater than one year, is the fact that, if the life should remain healthy, he has the option of dropping the one Policy and effecting another for the remainder of the term at a lower rate (see page 281); and accordingly the above formula requires modification for

(1) Very short or very long terms.
(2) Varying Office rules regarding medical fee, commission, etc.
(3) The option referred to.

Joint Life Term Assurances.

To calculate the true theoretical pure premium for Joint Life Term Assurances is a troublesome operation; but, for all ordinary ages and terms, it is unnecessary labour, because it will be found that the addition of the individual pure premiums gives a very good approximation to the true Joint Life rate, exceeding it by a small sum only. The single payment for such a policy may be expressed thus:—

$$A^{1}_{\overline{xy}:\overline{n}|}=A^{1}_{x\,\overline{n}|}+A^{1}_{y\,\overline{n}|}-A^{1}_{\overline{xy}:\overline{n}|},$$

and the last term, representing the premium for an assurance payable on the second death taking place within the n years,

may be neglected, without seriously affecting the result, unless the term should be long or the lives advanced in age.

Students frequently make the assumption that an equation of similar form is also mathematically accurate in the case of annual premiums; but it will be at once apparent that this is not so on transforming the above equation into annual premiums, thus:—

(*a*) The correct formula is $$\frac{A^{1}_{\overline{xy}:\overline{n}|}}{a_{xy:\overline{n}|}}=\frac{A^{1}_{x\overline{n}|}+A^{1}_{y\overline{n}|}-A^{1}_{\overline{xy}:\overline{n}|}}{a_{xy:\overline{n}|}};$$

(*b*) while the fallacious formula assumes that $$\frac{A^{1}_{\overline{xy}:\overline{n}|}}{a_{xy\overline{n}|}}=\frac{A^{1}_{x\overline{n}|}}{a_{x\overline{n}|}}+\frac{A^{1}_{y\overline{n}|}}{a_{y\overline{n}|}}-\frac{A^{1}_{\overline{xy}:\overline{n}|}}{a_{\overline{xy}:\overline{n}|}}.$$

Under certain classes of policy the assumption of formula (*b*) would result in very considerable error; but in the case of short term assurances, for all ordinary periods, it will be found that a very close approximation to the true rate is obtained by adding the two individual rates. If (*y*) be the older of two lives the Office premium may, therefore, be thus expressed:—

$$P^{1}_{\overline{xy}:\overline{n}|}=P^{1}_{y\overline{n}|}+\pi^{1}_{[x]\overline{n}|}(1+\phi) \qquad (6)$$

where ϕ represents a percentage (say $7\frac{1}{2}$ or 10 per cent.) to provide the slightly heavier commission and expense.

The following table shows the difference between the approximate pure annual premium and the true premium, according to Sprague's Select Tables at $3\frac{1}{2}$ per cent. interest,

$$100\{(\pi^{1}_{[x]\overline{n}|}+\pi^{1}_{[x]\overline{n}|})-\pi^{1}_{\overline{[xx]}\overline{n}|}\}:—$$

Term n.	Ages 30, 30.			Ages 40, 40.		
	Approximate Rate.	Correct Rate.	Excess of Approximation.	Approximate Rate.	Correct Rate.	Excess of Approximation.
1	·870	·868	·002	1·062	1·059	·003
3	1·290	1·282	·008	1·534	1·525	·009
5	1·482	1·473	·009	1·810	1·794	·016
7	1·606	1·592	·014	2·002	1·981	·021
10	1·738	1·721	·017	2·244	2·210	·034

Joint Life Endowment Assurances.

An ingenious and practical formula, for obtaining approximately the pure premium for a Joint Life Endowment Assurance, was given recently by Mr. Lidstone (*J. I. A.* xxxiii. 354), who showed, by verbal explanation and a series of examples, that good results are obtained for almost all ages and terms. The formula is:—

$$\pi_{xy\overline{n}|}=\pi_{x\overline{n}|}+\pi_{y\overline{n}|}-\pi_{\overline{n}|} \qquad (7)$$

where $\pi_{\overline{n}|}$ denotes the sinking fund, payable in advance, which will amount to 1 in n years. The formula is fully explained by Mr. Lidstone. It need only be added that Office premiums may be introduced with fairly satisfactory results; and this affords a

convenient means of placing a rapid check upon any calculation of this nature.

Double Endowment Assurances.

The Double Endowment Assurance benefit consists of an ordinary Endowment Assurance of £100, combined with a Pure Endowment of £100, payable should the life survive the term; or, it may be expressed as a Term Assurance of £100, combined with an Endowment of £200 payable at the end of the term.

The premiums for such assurances differ from Whole Life and ordinary Endowment Assurance premiums in one important respect, viz.:—that if the rate of Mortality assumed in the calculations be heavier than Select Mortality, then while for Whole Life and Endowment Assurances the premiums would be increased on account of such heavier Mortality, the premiums for Double Endowment Assurances *would be diminished.* This, of course, is caused by the fact that the premium for the Endowment portion of £200 is reduced by the high Mortality, to a greater extent than the increase in the premium for the Term Assurance of £100. Office premiums for such benefits should therefore be calculated by a Table taking a very favourable view of Mortality, even more so than the Select Tables, if such were available. The experience of several Offices has been that Endowment Assurances are subject to a lighter Mortality than the other classes of Policies, and presumably the same feature will be observed, and that to a greater extent, in the case of Double Endowment Assurances. A Table of such rates will be found very useful in the case of a proposal on a life whose physical examination may be satisfactory, but who may have to be rated up for family or personal history, and who objects to pay the extra premium imposed. In many such cases the suggestion to place the life in the Double Endowment Table, without extra, would be satisfactory to all parties. It will be readily seen, however, that absolutely unhealthy lives cannot be accepted even in this class; because a point will be reached in the increase of Mortality when the Term premium alone will exceed the rate required for the combined benefit in normal circumstances. In granting such Policies, therefore, while the strictness of the medical examination may be relaxed, it is necessary to have some reliable evidence to show that the life proposed does not belong to the absolutely uninsurable class.

Debenture Policies.

The 5 per cent. Debenture Policy is a form of assurance of which one or two Offices have endeavoured to make a specialty in recent years; but it is very doubtful if anything like a satisfactory business has been done under the special schemes set forth. The Office granting the policy undertakes to retain the Sum Assured on the death of the policyholder, and to pay interest thereon, usually at the rate of 5 per cent., for an agreed-on period of ten or twenty years (say *n* years).

Of course it will be readily understood by members of the Actuarial Society that an Office can quite well afford to offer 5 per cent., 6 per cent., or even 10 per cent. for a limited term, if the premium to cover this interest be calculated on a proper basis. It is open to question, however, whether Life Offices have been wise in following the lead of American Companies and placing before the public such 5 per cent. and 6 per cent. Debenture Policies; because it is not easy to remove from the minds of ordinary investors, the idea that the security is in an inverse ratio to the rate of interest, and he will look upon the 5 per cent., or 6 per cent., as interest and not as part of the Sum Assured. If a rate of 4 per cent. only were guaranteed, and an option given to take payment of the Sum Assured at any time during the n years, then the rates for such policies would approximate more closely to the ordinary Life rates, and the scheme might prove more popular.

It is desirable to base any special calculation of this character, as far as possible, upon the premiums for the usual benefits granted; and in the case under consideration this may very readily be done. It is only necessary to fix upon a rate of interest which may be counted upon as likely to be realised for the period of n years after the death of the Assured. If this rate be i, and the rate of interest guaranteed be j, then the premium charged should be such as will provide the Sum Assured at death and also the present value at that date of an annuity certain of $(j-i)$, payable half yearly during the subsequent n years. The formula may therefore be expressed—

$$P' = P_x \{1 + (j-i)\, a^{(2)}_{\overline{n}|i}\} \qquad (8)$$

where P' is the special premium required and P_x is the ordinary Office non-profit rate, $a^{(2)}_{\overline{n}|}$ being taken at rate i.

The principal difficulty lies in fixing the rate to be assumed for i, and opinions on the subject differ widely, because it involves, not the ordinary duration of human life, but a further period of n years, commencing at the time when the Sums Assured usually become payable. Judging from published premiums, it would appear as if $3\frac{1}{2}$ per cent. were the rate most frequently made use of in such calculations. If then the Office can earn $3\frac{1}{2}$ per cent. on the Sum Assured retained in its possession, the additional interest of $\frac{1}{2}$ per cent.—making 4 per cent. in all—should be provided out of the premiums paid during the lifetime of the Assured. All difficulties as to loadings are got rid of by using the Ordinary Office rate. It should be observed, however, that no allowance is made for expenses after the death of the Policyholder, such as the investment of the money, and the half-yearly payment of interest to the beneficiaries.

Probably the simplest form of the Policy under consideration is that adopted by one Office which, accepting the usual rate of

premium, undertakes to pay 3½ per cent. interest on the Sum Assured for twenty-one years after a claim may arise. This raises an interesting question as to the reserve which the Office will make for such Policies, the valuation rate of interest being 3 per cent. only. The guarantee of 3½ per cent. interest, strictly speaking, requires that the reserve should be considerably greater than that under the ordinary Policies, although the premium payable in each case is exactly the same. This question is perhaps passing beyond the scope of the present paper; but it calls attention to one of the difficulties to be met in the adoption of the scheme referred to, and indicates that those Offices which have been strict enough to assume that they will realise 3 per cent. only after the maturity of the Policy have taken the more prudent course; and it also points out that the earning of surplus interest in the early years, can scarcely be looked upon as making provision for the possibly smaller earning power of money in the future, unless any surplus interest so earned be not distributed at the early investigations, but be carefully preserved and set apart. Moreover, the absence of any provision in the above formula for the Investment and other expenses, already referred to, makes it necessary that the rate of interest assumed should be a net rate to be realised after all such expenses, income-tax, etc., have been deducted. A full consideration of the subject, therefore, would point to the conclusion that a rate of 3½ per cent. is too high, and that not more than 3 per cent. should be assumed.

The rates for such policies, assuming that 3 per cent. interest be realised while the Sum Assured is retained in possession, and making use of the Whole Life Non-profit rates recommended by Dr. Sprague, are as follows:—

10 YEARS.

Age.	6% Debenture Policy.	5% Debenture Policy.	4% Debenture Policy.	Whole Life Rate.
20	£2 2 5	£1 19 7	£1 16 8	£1 13 9
30	2 11 3	2 7 9	2 4 3	2 0 9
40	3 9 0	3 4 3	2 19 6	2 14 10
50	4 19 8	4 12 10	4 6 1	3 19 3

20 YEARS.

Age.	6% Debenture Policy.	5% Debenture Policy.	4% Debenture Policy.	Whole Life Rate.
20	£2 8 11	£2 3 10	£1 18 10	£1 13 9
30	2 19 0	2 12 11	2 6 10	2 0 9
40	3 19 5	3 11 3	3 3 0	2 14 10
50	5 14 10	5 2 11	4 11 1	3 19 3

The same principle is sometimes also applied to other classes, such as Endowment Assurance Policies when the rate of interest (j) is usually guaranteed throughout the remainder of the lifetime of the policyholder; or the Sum Assured may be payable at the death of the survivor of a husband and wife, interest thereon being guaranteed after the death of the husband, during the survivance of his widow. The above formula readily adapts itself to meet varying circumstances.

Survivorship Assurances.

The subject of Survivorship Assurances was fully discussed by the late Mr. A. W. Sunderland (*J. I. A.* xxvii. 81), who drew attention to the great divergence in the rates of various Offices. He pointed out that not only were the Lives Assured select, being medically examined, but that the counter lives should also be treated as select, because such were most frequently ladies in comfortable circumstances, life-tenants of Trust Funds, and also because the persons effecting the Policies would be unlikely to do so should the life-tenants be in poor health. Mr. Sunderland, accordingly, adopted a modification of Sprague's Select Mortality for the Life Assured, and the Government Female Annuitants' Experience for the counter life, and compared the Survivorship premiums thus brought out with those deduced from the Carlisle and H^M Tables. Until within very recent years, the Carlisle Table was almost invariably used for such calculations, although the H^M Table was adopted by several Offices. Mr. Sunderland's calculations show that, on the strict basis he assumed, the H^M values come out considerably too small at the principal insuring ages both for single and annual premiums; but that the Carlisle values, particularly the annual values, approximate closely to the basis of comparison, and on the average err on the safe side. The Tables of pure premiums, prepared in 1851 by Gray Smith and Orchard, on a Carlisle 3 per cent. basis, were thus shown to be safe for adoption; and, while it would certainly be desirable to take selection into account, by making an exact calculation at one or two of the principal and extreme ages, in the case of the computation of a complete new table of such premiums, yet for isolated and special calculations, unless of exceptional magnitude, the Carlisle Table may still properly be employed.

It will be remembered that the usual formula A^1_{xy} must be modified before it can be applied to select values:

$$A^1_{xy}=\tfrac{1}{2}\left\{Axy+\frac{a_{x-1:y}}{p_{x-1}}-\frac{a_{x:y-1}}{p_{y-1}}\right\}$$

$$=\tfrac{1}{2}\left\{Axy+\frac{vp_{x-1:y}\mathfrak{a}_{x:y+1}}{p_{x-1}}-\frac{vp_{x:y-1}\mathfrak{a}_{x+1:y}}{p_{y-1}}\right\}$$

$$=\tfrac{1}{2}\{Axy+vp_y\mathfrak{a}_{x:y+1}-vp_x\mathfrak{a}_{x+1:y}\}$$

whence $$A^1_{[xy]}=\tfrac{1}{2}\{A_{[xy]}+vp_{[y]}\mathfrak{a}_{[x]:[y]+1}-vp_{[x]}\mathfrak{a}_{[x]+1:[y]}\}.$$

Assurance on x against y and for t years longer.—If, as is usual, the annual premium for this risk be payable during the joint lives and until t years after the death of y, and y should die in the early years of the assurance, a temporary Policy on x's life for the t years can, if he be still in good health, generally be obtained at a rate less than the Survivorship premium payable. Further, the last premium payable would, on an average, after taking the days of grace into account, carry the assurance for a period of five months only; and accordingly it would only be paid in exceptional circumstances, such as the life being in bad health, or the final period approximating to a full year. 'The 'Office, therefore, which grants a Policy at the customary annual 'premium, cannot reckon upon receiving this premium in all cases, 'even although it provides in all cases the assurance for which this 'premium is the proper payment.' The matter is of no great practical importance except when $t=1$. In this case the difficulty can be best met by making the premium payable during the joint lives only. Mr. Sunderland suggested that the mean of the two premiums $\left(\frac{A^{1}_{x:\overline{y}|\overline{t}|}}{a_{xy}}\right)$ and $\left(\frac{A^{1}_{x:\overline{y}|\overline{t}|}}{a_{x:\overline{y}|\overline{t}|}}\right)$ might be charged during the joint lives, and a final payment, one-half of such mean, due six months after the death of y, and this also would be a satisfactory method of overcoming the difficulty.

Mr. Sunderland gives for decennial ages a 'Table of the 'corrections, to be added to the calculation of annual premiums for 'ordinary Survivorship Insurances, in order to extend the term 'for one year beyond the death of the counter life,' and the adjusted premiums for individual ages may be obtained by simple interpolation with quite sufficient accuracy, without the necessity of making further calculation. Mr. Chatham had formerly (*J. I. A.* xxv. 441) published, on an H^M 4 per cent. basis, the additions required to the annual premiums when $t=1$, 3, 5, 7 or 10 years, and this Table forms an admirable check upon any calculation of this nature.

Special Contingency Assurances.—It is often desirable, before making any elaborate calculations, to examine the simple probabilities of the occurrence of the event, omitting the element of interest entirely, and perhaps in some cases even neglecting any probability which may be known to be of trifling value. By this means it will often be found that the premium would work out at a mere nominal figure, far below what any Office would dream of charging for the issue of a Policy; and a troublesome calculation may be avoided. However slight the risk may be, a Life Office would not care to issue a Policy at a smaller annual premium than 10s. or 15s. per cent.

As an example, take the case of an assurance payable in event of two lives aged 20 and 30 predeceasing a life aged 40 within ten

years. The rough approximate probability by select mortality is

$$(1-{}_{10}p_{[20]})\,(1-{}_{10}p_{[30]})=\cdot 00806$$

showing a *single* premium of about 16s. per cent., so that it is clearly a case for the lowest rate of annual premium which can be charged. Moreover, the figure above-mentioned is too high, as it neglects interest and also the possibility of the life aged 40 dying prior to the death of the last survivor.

Anomalies.

In framing premium rates great care must be exercised to see that the various Tables are consistent with one another. If one principle be followed throughout the calculations, there is but little chance of anomalous rates being produced; but if different rules be adopted for different classes of policies, there is a risk that one table may appear absurd when compared with another. In addition to the points taken up incidentally throughout these notes, the following may be mentioned as illustrating the character of the inconsistencies which might arise:—

(1) The whole life non-profit rate has been known to exceed the rate for an Endowment Assurance maturing at an advanced age.

(2) The premium under an increasing premium policy during the first five years is sometimes smaller than the corresponding short term rate.

(3) The loading for bonuses may in some cases appear absurd—more particularly under Endowment Assurances for a short term, when the difference between the With and Without profit rates should be kept in view.

(4) The Survivorship Assurance rates (x against y)+(y against x) should never fall short of—indeed they should slightly exceed—the Joint Life rate for x and y.

(5) Joint Life and Last Survivor rates taken together should show a fair agreement with the corresponding Whole Life rates at the individual ages.

Extra Premiums.

According to the rules of most Offices, a higher rate of premium than that charged for normal select risks is exacted should the life follow an occupation under which the average life-time is short, or should he proceed to an unhealthy climate. Thus, it is found necessary to charge an extra premium varying from 5s. per cent. to 30s. per cent., for hotelkeepers and publicans, naval and military men, mariners, miners, and many other small classes, such as stonecutters, steel-grinders, chemical workers, jockeys, etc.; while some Offices even subject working bakers, butchers, millers, and other such lives to an extra premium. These extra rates are to a considerable extent fixed arbitrarily, or according to certain general Office rules, and much difference of opinion exists as to the proper charges. Similarly it will be found that the practice of Offices varies greatly in the treatment of persons proceeding abroad. It is now usual, however, to allow free travel and residence after the policy has been in force for several years; while there seems also to be a growing tendency to issue world-wide policies from the commencement, unless it be shown that the life proposed for assurance actually contemplates residence in a tropical climate.

Occupation and Residence.

Female lives are charged higher rates than male by the majority of Offices, the general practice in Scotland being to impose an extra of 5s. per cent., removable after the age of 50, together with a single extra premium of 10s. per cent. should the life be pregnant for the first time when the proposal is made. Assurances on female lives appear to be on the increase, and the proper course would, perhaps, be to calculate special rates, and treat the class separately for the purpose of bonus distribution. If Whole Life policies were effected to any extent, considerable profit might be derived from superior vitality at the older ages; but if, as would seem probable, Endowment Assurances formed the popular class of policy, then there would not be the same scope for profit, as the policies would mature shortly after the cessation of the Extra Mortality to which female lives are subject.

Sex.

When, as the result of the Medical Examination or Family History, it is found necessary to treat the lives proposed as under-average, though not to decline the proposals altogether, there are various ways in which such are surcharged:—

Rated-up Lives.

(1) By adding n years to the age, charging the premium for age $x+n$.

(2) By adding a fixed sum to the premium payable for the normal risk.

(3) By charging the normal premium, but making a temporary deduction from the Sum Assured, such deduction being either fixed during a certain number of years, or decreasing year by year until it ultimately vanishes should the life survive an agreed-on term—usually the Expectation of Life at the normal age.

(4) When the necessary extra is small, by stipulating that Bonuses under a With Profits policy shall not vest until a certain term have been survived, etc.

The first two methods are very similar in results, while the third has been proposed for those cases (such *e.g.* as a family history of consumption) where the proposer may personally consider himself to be a good life, and object to pay any extra. The late Mr. Sunderland (*J. I. A.* xxix. 419) treated this question by equating the premium for the increasing sum assured, at the rated-up age, with the premium for the level sum assured at the real age. Thus, if the life were rated up n years, the temporary decreasing deduction from the sum assured would be got by solving for X in the following equation :—

$$P_x=(1-mX)\pi_{x+n}+X\frac{R_{x+n+1}-R_{x+n+m+1}}{N_{x+n-1}}+e+b.$$

Where m = Number of years during which the deduction continues.
X = Amount by which the deduction is decreased each year.
$\therefore$ mX = Initial deduction.
e and b = Loadings for expenses and bonuses respectively. They are put in this form in order that such specially surcharged cases may be properly dealt with in Bonus Distribution.

For practical purposes it may be assumed that the loadings for expenses and bonuses are the same at ages x and $x+n$, when the formula works out :—

$$X\left(m\pi_{x+n}-\frac{R_{x+n+1}-R_{x+n+m+1}}{N_{x+n-1}}\right)=\pi_{x+n}-\pi_x.$$

If the deduction be a fixed amount during the period of m years the following is applicable :—

$$X=\frac{\pi_{x+n}-\pi_x}{\pi_{x+n:\overline{m}|}^{\;\;1}}.$$

An erroneous method, sometimes adopted for a similar case, is to find the sum assured for which the normal premium would pay at the rated-up age, and treat this as the restricted sum assured during the Expectation period. If the deduction were continued during the whole currency of the policy the method would of course be correct; and Mr. Day pointed out that a rough approximation to correct results would be obtained by increasing the deduction by one-third to allow for its being removable should the Expectation be survived.

Mr. G. F. Hardy (*J. I. A.* xxxii. 153) also discussed this question on the following assumptions:—

1*st*, That the extra mortality is confined to the period during which the sum assured is restricted—the life being thereafter assumed normal.

2*nd*, That the extra risk is so distributed that the Reserve Value of the policy equals that of a corresponding normal policy.

On these assumptions the following equation will hold:—

$$q'_{x+t}\{1-(m-t)X-{}_{t+1}V_x\}=q_{x+t}(1-{}_{t+1}V_x)$$

where t = number of years the policy has been in force.

Mr. Hardy then proceeded to find the number of years' rating, corresponding to certain *assumed* values of X, by first computing the values of q'_{x+t} for all values of t up to $t=m$, and then calculating the annuity value $a'_x=a_{x+n}$, from which n the number of years' extra rating was found. By an extensive use of interpolation the work was much reduced.

The results deduced by Mr. Hardy agreed fairly well with those of Mr. Sunderland, and both pointed to the fact that the rough methods frequently adopted bring out inadequate deductions. The tables which they publish are useful when any question of the kind arises. The general conclusion seems to be that this method of rating is unsatisfactory, because the initial deduction is very heavy, even when only 3 or 5 years are added to the age; while for a life heavily rated, the requisite deduction might exceed the sum assured.

Extra rating for Joint Life and Last Survivor Assurances.

Under a joint life policy, when one of the lives is subject to Extra Mortality on account of occupation, residence, or sex, it is usual simply to add the extra premium necessary for the single life, to the ordinary joint life rate, and it may be shown by exact calculation that this is approximately correct. Under a last survivor policy, however, this addition would be too great, and for such cases the following practical method is found to give a good approximation:—

Assume that one of the lives (y) incurs extra risk which would be covered under a single life policy by an addition of 5s. per cent.

Find age (z) where $P_y+\cdot0025=P_z$, and charge the last survivor premium P_{xz}.

This rule gives very fair results when tested by the more exact methods after-mentioned.

A Hypothetical Table of Mortality was formed by Mr. Ryan (*J. I. A.* xxiv. 19) by adding ·01 to π_x (H^M 3 per cent.) at each age, and deducing the rate of mortality corresponding. He showed by actual calculation (*J. I. A.* xxiv. 307) that if 5s., 10s., and 20s. respectively be added to the H^M premium, and the rates of mortality deduced (written $q_x^{\cdot 0025}$, $q_x^{\cdot 005}$ and $q_x^{\cdot 01}$), the following relations hold :—

$$q_x^{\cdot 01}=q_x+4(q_x^{\cdot 0025}-q_x)\,; \qquad \text{or } q_x^{\cdot 0025}=q_x+\cdot 25(q_x^{\cdot 01}-q_x)$$
$$q_x^{\cdot 01}=q_x+2(q_x^{\cdot 005}-q_x)\,; \qquad \text{or } q_x^{\cdot 005}=q_x+\cdot 5(q_x^{\cdot 01}-q_x)\,;$$

and from these equations it may be assumed that

$$q_x^{\cdot OE}=q_x+E(q_x^{\cdot 01}-q_x),$$

where E represents the uniform addition to the annual premium. Joint Life annuities giving effect to the extra mortality were then calculated, premiums were deduced from them, and the Extra Premiums obtained as follows:—

$$E_{ex}\ \{\text{one life } (e) \text{ being exposed to extra risk}\}=E(P_{ex}-P_{xy})$$
$$E_{ef}\ \{\text{both lives exposed to extra risk}\}=E(P_{ef}-P_{xy}).$$

These Extras were found to agree closely with those deduced by the approximate method above mentioned.

The Hypothetical Mortality Table may be put to several other uses, such as finding the Extra under a Contingent Assurance when the Life Assured goes abroad, or investigating from the experience of an Office whether an extra rate, climatic or otherwise, has been adequate, by bearing in mind the relationship

$$q_x^{\cdot OE}=q_x+E(q_x^{\cdot 01}-q_x).$$

The table referred to brought out an addition to the rate of mortality nearly uniform throughout life; and it is interesting to note that the late Mr. Makeham had formerly discussed the question of Extra mortality by assuming a constant addition to the *force* of mortality. The Extra required for an addition of ·01 to the force of mortality might be found from the formula

$$\pi'_x-\pi_x=\frac{1}{\mathbf{a}'_x}-\frac{1}{\mathbf{a}_x},$$

where it would be sufficiently accurate in practice to take $\mathbf{a}'_x$ at a rate of interest 1 per cent. higher than is used for $\mathbf{a}_x$. Under joint life policies where one life only is exposed to extra risk, the corresponding annuities should be inserted in the formula; while, if both lives be so exposed, $\mathbf{a}'_{xy}$ should be taken at a rate of interest 2 per cent. higher than that for $\mathbf{a}_{xy}$.

When a policy has been in force for a number of years, and an extra premium at a certain rate per cent., becomes exigible, this percentage should properly be charged upon the difference

between the sum assured and the reserve value of the policy, this being the true sum at risk. Further, Mr. R. P. Hardy has pointed out (*J.I.A.* xxiv. 320) that, in the case of a Last Survivor Policy, the extra premium should be levied upon the sum by which the reserve would have to be increased on the failure of the life undergoing the extra risk.

Rated-up Endowment Assurances.

The addition to an Endowment Assurance premium should in most circumstances be somewhat less than the corresponding addition to a Whole Life premium, because of the distinct double benefit, the extra risk under the term assurance being partly met by the diminished risk under the pure Endowment. If, therefore, an extra of 5 years be found necessary to a life aged 30, the addition to a Whole Life Policy would be about 6s. per cent., while the corresponding addition to an Endowment Assurance Policy of 30 years would only be about 3s. per cent. If the Endowment Assurance be expressed as payable at age 60, the surcharged premium would be found by assuming the life to be 35, and the sum assured to be payable at 65. In practice different methods are adopted in the treatment of such policies, and some offices add to the Endowment Assurance normal rate the cash extra which would be payable under a whole-life policy.

In some cases, however, a proposal may be accepted at ordinary rates under an Endowment Assurance Policy, although an extra may be necessary under a Whole Life Policy—where, for example, the reason for the extra is a family history of gout, affecting only the later years of life, while the Endowment Assurance matures at a comparatively early age. On the other hand, if the extra risk falls entirely in the first few years of the assurance, then a *larger* addition is almost necessary, because when the extra risk has been passed the additional premium continues payable under a Whole Life Policy for a much longer period than under an Endowment Assurance. Generally, therefore, it may be said that *the rating up of Endowment Assurances depends upon the incidence of the Extra Mortality.*

Policies for Children.

Assurances on the lives of children are sometimes effected when there exists a pecuniary interest in the child's life. At very young ages it is necessary to charge a decreasing premium for a whole life or term assurance, because the rate of mortality—great in the early years—decreases rapidly, with the result that the level premium would not meet the risk during the first year or two.

Children's Endowments.

As an Endowment is not dependent upon death, such Policies may be effected without any pecuniary interest, and this has become a very usual form of transaction, entered into by parents for the benefit of their children. The premiums, if non-returnable in event of the child dying before attaining the specified age (say 21), are, like Double Endowment Assurance premiums, higher with a light than with a heavy mortality, and accordingly it is the usual practice to employ a Table showing favourable mortality, such as that deduced from the experience of the children of the peerage. To make use of a Table based upon the experience of the general population would be entirely erroneous, because all classes are included in such statistics; and, further, there is a decided selection exercised against the Office, such Endowments being purchased only on the lives of the healthiest of children. It is questionable, therefore, if even the Peerage Tables go quite far enough in this direction; for, while the *class* from which the statistics have been taken is doubtless properly chosen, the further element of selection has an effect upon the mortality. It should be noted that when the Endowment period runs for n years, and not up to a fixed age, the calculations should properly be made according to the age *last* birthday, otherwise a slight benefit is given to the proposer. The matter is, however, of little practical importance; because pure Endowments of this nature are not at all popular, the returnable premium system being almost invariably chosen.

When the premiums are returnable, the exact rates may be calculated by means of a formula derived from the following equation, where $\pi'_{x\overline{n}|}^{1}$ represents the net premium to be found, and $P'_{x\overline{n}|}^{1}$ is the same expression loaded:—

$$\pi'_{x\overline{n}|}^{1}\mathbf{a}_{x\overline{n}|}=\,{}_nE_x+P'_{x\overline{n}|}^{1}IA^{1}_{x\overline{n}|}.$$

But it is scarcely worth while to introduce the element of mortality. All that the Office can gain should the child die before attaining age 21 is the interest on the net premiums received; while out of this interest the expenses have to be met the premiums being usually refunded in full. If mortality be left out of account, the question becomes 'what annual premium

payable in advance will, after deducting expenses, amount to £100 in n years.' Under this class of policy the expenses are usually light, the agent's commission being about 5 per cent. on the premiums; and if the modified loadings of 2s. 6d. constant, plus 5 per cent., be allowed for, it will be found that to produce reasonable competitive rates it would be necessary to assume $3\frac{3}{4}$ per cent. interest in the calculation. The Office retains any slight profit which may arise from surplus interest in those cases, small in number, where premiums fall to be refunded; and, further, Life Offices look upon such Policies as desirable, because of the possibility of the recipient of the Endowment taking out an ordinary Life Assurance Policy, or an Endowment Assurance, when the money comes to be paid. The formula suggested above would of course be written:—

$$\{\cdot 95\, P_{\overline{n}|} - \cdot 00125\}(1+i)S_{\overline{n}|} = 1$$

$$\text{whence } P_{\overline{n}|} = \frac{1}{\cdot 95}\left\{\frac{1}{(1+i)S_{\overline{n}|}} + \cdot 00125\right\}. \qquad (9)$$

It is sometimes arranged that the premiums, returnable on the death of the child, should cease in event of the death of the person (y) entering into the transaction, who would in such case undergo a medical examination. The theoretic premium might be arrived at by equating the Benefit and Payment as follows:—

$$\text{Payment} = \pi\frac{N_{x-1:y-1} - N_{x+n-1:y+n-1}}{D_{xy}},$$

$$\text{Benefit} = \frac{D_{x+n}}{D_x} + P.\frac{M_x - M_{x+n}}{D_x} + p_y.P.\frac{M_{x+1} - M_{x+n}}{D_x}$$

$$+ {}_2p_y.P.\frac{M_{x+2} - M_{x+n}}{D_x} + \ldots + {}_{n-1}p_y.P.\frac{M_{x+n-1} - M_{x+n}}{D_x}.$$

The mortality affecting x might, however, be neglected, and the question viewed thus:—

The premium for an ordinary Endowment, with return, would be $P_{\overline{n}|}$, the prospective value of all the premiums being $P_{\overline{n}|}\mathbf{a}_{\overline{n}|}$. The same value should be paid during the lifetime of (y), and accordingly the premium for the special benefit would be

$$P' = P_{\overline{n}|}\frac{\mathbf{a}_{\overline{n}|}}{\mathbf{a}_{y:\overline{n}|}}. \qquad (10)$$

This approximation gives rates erring slightly in favour of the Office on account of the premiums being, on the average, paid in a shorter period, so that more interest may be earned during the n years.

An Endowment does not appear to be viewed by the Inland Revenue authorities as a 'Policy of Assurance,' as the adjudicated stamp-duty required is only 6d., whatever the amount of the Endowment may be—*i.e.* an ordinary agreement stamp.

Another form of Policy sometimes effected for the benefit of children is the Deferred Assurance, with return of the premiums paid if death take place before the benefit falls to be entered upon. It would seem to be unlikely that this form of Assurance will ever become really popular, because it means that the person effecting it is making provision, not for his own child as under the Endowment, but for the heirs or assignees of such child whoever they may be. The Assurance usually commences at age 21; and, as the premiums for the preceding years are accumulated, it follows that the rate per cent. is very low, and that the Office enters upon the risk with a considerable reserve value in hand. Sometimes a medical examination of the child is required, but generally this is dispensed with, although in the latter case it would appear as if a certain amount of selection might be exercised. If the age at entry be x and the age at which the risk commences be $x+n$, then the difference in value between the ordinary premium for age $x+n$ and the special rate charged under this class of Policy, must remain in hand when the risk commences. Neglecting mortality therefore during the n years, as suggested for the Endowment calculation, the special premium P' may be found as follows, the loadings being the same as in formula (9):—

Deferred Assurances for Children.

$$(\cdot 95\,P' - \cdot 00125)(1+i)S_{\overline{n}|} = (P_{x+n} - P')\mathbf{a}_{[x]+n}$$

$$\text{whence } P' = \frac{P_{x+n}\mathbf{a}_{[x]+n} + \cdot 00125(1+i)S_{\overline{n}|}}{\cdot 95(1+i)S_{\overline{n}|} + \mathbf{a}_{[x]+n}}. \qquad (11)$$

As the premium P_{x+n} represents the ordinary Office rate, it follows that the life is, in the above formula, assumed to be healthy when the assurance is entered upon. As this assumption is incorrect, there should properly be added to the numerator of the equation the quantity $\{\pi_{[x]+n} - \pi_{[x+n]}\}\mathbf{a}_{[x]+n}$. This addition is somewhat greater than is theoretically necessary, because, as already mentioned, a considerable reserve value is held when the assurance commences, and the risk entered upon is only the difference between the sum assured and the reserve value. The excess may, however, be looked upon as loading to what would otherwise be a net addition, and the formula taken for practical purposes:—

$$P' = \frac{\{P_{x+n} + (\pi_{[x]+n} - \pi_{[x+n]})\}\mathbf{a}_{[x]+n} + \cdot 00125(1+i)S_{\overline{n}|}}{\cdot 95(1+i)S_{\overline{n}|} + \mathbf{a}_{[x]+n}}. \qquad (12)$$

The above formula, being based upon the Office premiums for the usual benefits, lends itself very readily to modifications for Limited Payment and Endowment Assurance Policies, and also for Assurances 'With Profits,' when, of course, the bonuses would accrue from the date of commencement of risk.

Options.

It is not at all an unusual form of transaction for a Company to undertake to issue a Policy to a person (x) a number of years (n) hence at the ordinary rate of premium for his then age, whatever may be the state of his health at that time. Dr. Sprague investigated this risk (*J. I. A.* vol. xxii.), basing the inquiry upon Annuities and Reserve Values, and brought out the pure single premium as

Option n years hence.

$$\frac{(uD)_{x+n}}{D_{[x]}}(uV)_{x+n},$$

and the Annual Premium as

$$\frac{(uD)_{x+n}}{\mathbb{N}_{[x]}-\mathbb{N}_{x+n}}(uV)_{x+n};$$

where u indicates that the symbol following is dependent upon an average unhealthy life. He then remarked regarding the Option by Annual Premium: 'It must be borne in mind, however, that 'if the Company agree to accept this annual premium in considera-'tion of undertaking the risk supposed, and the Assured retains 'the usual right of dropping the Policy, he will be able to exercise 'an Option which has not entered into the calculation; and the 'Company, therefore, could not agree to accept this annual premium 'unless it were in some way protected against the risk of this 'Option being exercised to its disadvantage. Such protection 'would be obtained by making the Option annual premium an 'addition to the ordinary premium for the ordinary Policy.'

Single and annual premiums for the foregoing Option may, however, be deduced in a much more simple and direct manner as follows:—

The premium which a select life presently aged (x) should, on the average, pay at age $x+n$ for this Deferred Assurance is . . . . . $\pi_{[x]+n}$.

The premium he will actually be required to pay is only . . . . . $\pi_{[x+n]}$.

The present Value of the difference between these premiums is evidently the sum which the Office should charge for the risk run, *i.e.*:—

$$\{\pi_{[x]+n}-\pi_{[x+n]}\}a_{[x]+n}\frac{D_{[x]+n}}{D_{[x]}},$$

which, on being simplified, may be written thus:—

$$\frac{\{\pi_{[x]+n}-\pi_{[x+n]}\}\mathbb{N}_{[x]+n}}{D_{[x]}}. \qquad (13)$$

This is a simple formula, very convenient for purposes of calculation, and it may easily be demonstrated as another form of that given by Dr. Sprague.

The following table gives the Single Option Premiums, per £100, at $3\frac{1}{2}$ per cent. interest, deduced from Sprague's Select Tables, and also from King's Analysed Tables:—

No. of Years n	Age 30.		Age 40.		n
	Sprague's Tables.	King's Tables.	Sprague's Tables.	King's Tables.	
1	·408	...	·503	...	1
3	·699	...	·896	...	3
5	·778	1·627	1·043	·404	5
7	·758	...	1·133	...	7
10	·630	1·491	1·142	2·218	10
15	·667	·616	1·005	1·400	15
20	·730	1·479	·920	1·782	20
25	·643	·881	·805	2·403	25

It will be observed that the results are exceedingly irregular, and that, according to King's Tables, considerably higher rates are found necessary than those deduced from Sprague's Tables. One would expect that the rate would increase to a maximum with the increase in the value of n, and thereafter gradually diminish to zero because of the two forces—deterioration and probability of death during the n years—acting in contrary directions; and indications of this feature are not wanting in the foregoing Table. The Select Values deduced by Dr. Sprague, and joined to the $H^{M(5)}$ values usually after three or four years, cannot be upheld as constituting a good basis for such calculations; because there can be no doubt but that the effects of selection endure for a much longer period. The method of construction of King's Tables would appear to be more suitable; but, on the other hand, their graduation is defective. One is forced to the conclusion that existing Tables are not sufficiently accurate for refined calculations of this nature, and that they only give general guidance towards the premiums which should be charged—very large margins being necessary.

Increasing Premium Policy.

Another form of the foregoing Option is contained in the Increasing Premium Policies now granted by almost all Offices. The premium for such an Assurance during the early years should, in addition to the usual term rate, include the annual payment required to cover the option of effecting an assurance at ordinary rates at the time the increased premium becomes payable. The requisite annual additions to the five-year term rates, per £100 assured, in order to arrive at lP_x, are as follows:—

Age.	Sprague's Tables. 3½ %.	King's Tables. 3½ %.
20	·158	·349
30	·169	·367
40	·227	·088
50	·358	·433

Under this class of Policy the Option seems to be very generally exercised, as only a small fraction of the policies enter upon their sixth year. It must also be seen that the increased premium does not exceed the normal rate for the ordinary Assurance at age $x+5$; otherwise the holder, if in good health, would have the option to drop the Policy, and secure the same benefit at a lower rate of premium.

Option to (x) on death of (y).

It sometimes happens in connection with reversionary transactions, that it is desirable to have the Option to effect a Policy on (x)'s life on the death of (y). Considering the case of (y) dying in the nth year, the single premium required at the date of acquiring the Option would, as already given, be

$$\frac{\{\pi_{[x]+n}-\pi_{[x+n]}\}\mathbb{N}_{[x]+n}}{D_{[x]}}.$$

The probability of (y) dying in the nth year is $({}_{n-1}v_{[y]}-{}_{n}p_{[y]})$, and accordingly the Option premium for the nth year would be

$$\frac{\{\pi_{[x]+n}-\pi_{[x+n]}\}\mathbb{N}_{[x]+n}}{D_{[x]}}({}_{n-1}p_{[y]}-{}_{n}p_{[y]}). \qquad (14)$$

The sum of this expression for all values of n will give the pure single premium required. This formula is not strictly correct, because it assumes that the Option is exercised at the *end* of the year in which (y) may die, but the difference in value must be trifling. It would, however, seem to be unnecessary even to make an elaborate calculation of this nature. It will be observed from the Table on the preceding page that the Option premiums are small for the first year, considerably greater for a three years' period, remaining roughly constant for the periods of three, five, and ten years, showing a tendency to decrease with the extension of the term. If, therefore, the expectation of life of (y) be taken, which in almost every case will exceed three years, and the above premium be calculated for such expectation treated as a fixed term, a sufficient approximation to the rate will be obtained.

Option to take Paid-up Policy.

Another Option benefit granted in a more or less complete form by the majority of Offices, is contained in the guaranteed Paid-up Policy arrangements (or non-forfeitable Policies as they are sometimes called), where a Paid-up Policy is issued, for that proportion of the Sum Assured which the number of premiums paid bears to the

total number payable. This question was investigated many years ago (*J.I.A.* xiv. 476, and xv. 151), and a formula given which took account of the *probabilities* of the various premiums being paid; but it is very evident that the option held by the Policyholder to continue his Policy for the larger or smaller amount is of greater consequence than the mere average probability of the premium being paid. If net premiums only are brought into the calculation, the difference between the reserve values of the full and reduced Policies forms the Option premium received by the Office. Taking, for illustration, the case of a Policy for £100 with premiums limited to 20 payments, effected at age 30, the following Table shows the position of matters after 5, 10, and 15 years, assuming Sprague's Select Tables with $3\frac{1}{2}$ per cent. interest to be adopted throughout:—

	(1) Reserve of Full Policy. (Select.)	(2) Reserve of Reduced Policy. (Select.)	(3) Δ {(1) - (2)}	(4) Option Premium.*	(5) Deficiency {(3) - (4)}
After 5 years,	9·543	9·576	— ·033	·584	·617
„ 10 „	21·105	21·140	— ·035	·315	·350
„ 15 „	35·017	35·095	— ·078	·167	·245

* The Option premiums inserted here are $\frac{3}{4}$, $\frac{1}{2}$, and $\frac{1}{4}$ respectively of the corresponding rates given on page 277; but a better idea of the loss to the Office through the exercise of the Option might be obtained by considering the matter thus:—

After five years the value of the contribution from a healthy life continuing the Policy would be . . . . . $= {}_{20}\pi_{[30]}\mathring{a}_{[35]:\overline{15}|}$

The contribution from an *average* life would be only . . . . . $= {}_{20}\pi_{[30]}\mathring{a}_{35:\overline{15}|}$

The difference between the two is evidently the loss to the Office through the healthy life dropping his Policy . . . . $= {}_{20}\pi_{[30]}\{\mathring{a}_{[35]:\overline{15}|} - \mathring{a}_{35:\overline{15}|}\}$

Viewed thus, the loss to the Office works out at 1·1, 1·8, and ·5 after 5, 10, and 15 years respectively.

The above Table gives, however, an exaggerated importance to the question, because it assumes that the *healthy* lives will take advantage of the Option and drop their Policies, effecting others or not according as their circumstances may require, while we know that the reason for such an alteration is much more frequently the inability of the holder to pay the premiums; so that the subject of health does not enter into the question to any appreciable extent. It will be observed, however, that the Paid-up Policy reserve, without taking any account of the Option, is greater than the reserve for the full Policy, so that the Office retains a larger reserve, while losing the benefit of any contribution

towards expenses from the Policy in the future, and this is certainly giving too great facilities to the Lives Assured for what may almost be termed 'breach of contract.' Indeed, according to the rules and rates of several Offices, it is more advantageous for a Policyholder to drop the one Policy and take out a new one than to continue his existing Policy, as the following example, taken from the prospectus of a Company, will show :—

Take the case of an Agent effecting a Policy for £1000 by 20 payments on his own life at age 20, Without Profits.

The premium he would be required to pay for the full amount according to the published rates of the Office referred to =	£24	10	10
After 5 years he can take a Paid-up Policy for £250, and assure for the balance of £750 by 15 payments for a premium of	23	3	2
After 5 more years he can do likewise, and the premium he has to pay is	22	8	4
Do. do. do.	21	16	11

The total sum payable in premiums under the Policy originally effected would have been £490, 16s. 8d.; but the same Assurance may be obtained at a total cost of £459, 16s. 3d., a saving by taking advantage of the Option, of £31 on the £1000 Policy. Moreover, as an Agent, he will have drawn his large initial commission on four different Policies for an aggregate sum of £2500, a further gain of nearly £15. Policyholders and Agents may not observe such features readily, as they have, by the wise foresight of our predecessors, been impressed with the idea that any breach of contract on their part by omission to pay premiums, will, in all circumstances, lead to considerable pecuniary loss; yet it is apparent that in the above hypothetical case a large *gain* may result from the dropping of the various Policies. Some Actuaries of the present day advocate strongly the giving of full values to Policyholders on withdrawal; but it would seem as if, in certain circumstances, Offices give greater benefits to those withdrawing than to those remaining—a condition of matters which should scarcely be.

This guaranteed Paid-up Policy can only be granted under limited payment assurances, with equity to other Policyholders, when effected With Profits, and some restriction is placed upon the participation of the reduced Policy. The practice of Offices differs considerably in this respect: some add the full Bonus declared and allow the reduced Policy to participate in full; others add only a proportion of the declared Bonuses, but allow the reduced Policy to continue participating; while some only add a proportion of the Bonus declared and make the paid-up assurance non-participating for the future, and they would seem justified in adopting this strict practice. Offices which allow these guaranteed Paid-up Policies to the full extent may of course argue that their

premiums are so calculated as to allow for the Option; but, if the premiums should be so calculated, then it must be borne in mind that the portion of the premium applicable to the Option must not be distributed as Profit, but must be carefully carried forward from Valuation to Valuation, and this would cause an unreasonable amount of trouble.

Under Endowments and Endowment Assurances, Paid-up Policies may be guaranteed without the same objectionable features, there being a considerable margin between the value of the full Policy and the value of the paid-up portion, as is shown by the following Tables, applicable to Endowment Assurances of 20 years by Sprague's Select Tables, at $3\frac{1}{2}$ per cent. interest:—

	Age 30 at Entry.			Age 40 at Entry.		
	Select Value of Full Policy.	Select Value of Paid-Up Policy.	Difference (1)–(2).	Select Value of Full Policy.	Select Value of Paid-up Policy.	Difference (1)–(2).
After 5 years, .	17·633	15·521	2·112	17·741	15·794	1·947
,, 10 ,, .	39·356	36·041	3·315	39·126	36·374	2·752
,, 15 ,, .	66·277	63·356	2·921	65·760	63·503	2·257

Option to drop Term Policy.

Reference has already been made to the Option possessed by the holder of a term assurance to drop his Policy time after time should he continue in good health, and always benefit by obtaining the same assurance for the reduced term at a lower rate of premium. This, which is a feature of all well-calculated term rates, is caused by the fact that the shortening of the term has a greater effect upon the mortality than the increase in age of the life. The following method of calculating Short Term rates, allowing for this Option, will be readily understood; the assumption being made that all the Policyholders whose health may have deteriorated will retain their existing assurances, while all those who may still be select at the end of each year will drop their present Policies and effect new assurances for the reduced term at a lower rate of premium.

Taking first the simplest case of a two years' Short Term rate in order to find $\pi'^{1}_{[x]\overline{2|}}$ (the pure premium allowing for this Option) we should have:—

$$\text{Benefit side} = \frac{M_{[x]} - M_{[x]+2}}{D_{[x]}}.$$

This, being the present value of the benefit in any event supplied, is accordingly also the present value of the payments which the Office must in any event receive.

There is yet another element in the calculation which is not allowed for, viz. :—that some of the lives who may be unhealthy at the end of the first year, are likely to regain their health, and thus be able to take advantage of the reduced rate at the end of the subsequent year, and so on; but this is a matter which in a general way is provided for by the method of construction of the select tables.

It will observed that for all values of n over 5, $\pi'^{1}_{[x]\,n|}$ becomes $\frac{M_{[x]}-M_{[x+1]}}{\mathbb{N}_{[x]}-\mathbb{N}_{[x+1]}}$, a constant quantity for each age at entry; but the fault lies in the assumption made in the Mortality Table that the effect of selection passes away in five years. For this assumption to be accurate it is necessary that all those whose health deteriorates in any year must, as Dr. Sprague assumes in the investigation already referred to, die within five years of such deterioration, and this is quite inconsistent with fact. For such questions to be answered properly, Mortality Tables running strictly according to policy years, and tracing the entrants at each age separately to their destination, would be necessary; and, as already explained, any calculations based on existing tables only yield general guidance towards the option values.

Policies Effected with Profits.

Many actuaries have deplored the system of granting Policies at rates higher that those required to meet the risk run and the expenses, and of thereafter returning the surplus to the Policyholders; but Bonuses have become popular and the demand must be met by Life Offices. There is, however, more to be said of Bonuses than that they meet a public want. Several Life Offices at the present day owe their existence to the system, for the Bonus margin has enabled such Offices to meet unexpected difficulties, whereas had the Premiums been at non-profit rates, the Office would have been hopelessly insolvent. In the case of Without Profit Policies the Sums Assured are guaranteed to a certain extent by the With Profit Policyholders, who pay more in Premiums for the opportunity of receiving Bonuses. Should the downward tendency in the rate of interest continue, the time may not be very far distant when non-profit rates may have to be calculated at 3 per cent. interest; and this would mean that existing premiums could not bear the existing expense rate, so that the Without Profit business would form a drag upon the Office. Undoubtedly the soundest and wisest course is to have, for With Profit Policies, rates of premium which will enable an office to bear any strain of this kind, or to restrict the basis of valuation in the future, should this be necessary. If no such strain arise, then large Bonuses will be the result, satisfactory to the public and to all concerned.

General Remarks.

When rates for With Profit Policies are required, the problems become much more complex than for Without Profit Assurances; because the Policyholders then take the place of partners in the business—the only partners in the case of a Mutual Office, and largely interested members in the case of a Proprietary Office. The benefits under With Profit Policies should therefore be equitable under all classes, so that one class of Policyholder can have no reason to say that another class is receiving an undue proportion of the surplus. It is the actuary's duty to see that the various classes of With Profit Policies are placed upon equal terms, and this is a matter of considerable difficulty. In order to overcome it, a number of offices have adopted a modified form of the contribution method of distribution, which, by allocating the surplus according to the source from which it is derived, enables them to mete out at least a rough form of justice to the various classes of Policyholders. The methods adopted by the offices of distributing their surpluses are very varied, but nevertheless With Profit Premiums should be consistent with whatever method may be followed. For the three most common methods of distribution, the following formulas are suitable, where it will be observed that,

after making a moderate allowance for expenses, the value of a certain assumed rate of Bonus is added. Under such Policies a 'margin for fluctuation' is not necessary, because the Bonus loading may be looked upon as making allowance for this factor.

(*a*) Constant Cash Bonus as percentage (ϕ per unit) on Office Premiums paid since last investigation—

$$P'_x = \frac{1\cdot05}{1-\phi}\left\{\pi_{[x]} + \frac{\cdot01}{a_{[x]}} + \cdot00125\right\}.$$

(*b*) Reversionary Bonus of b per unit for each premium paid during the quinquennium, constant for all ages and all durations of Policy, with Interim Bonus at same rate after first five years :—

$$P'_x = 1\cdot05\left\{\pi'_{[x]} + \frac{\cdot01}{a_{[x]}} + \cdot00125\right\}$$

$$\text{where } \pi'_{[x]} = \frac{M_{[x]} + 5bM_{[x]+5} + bR_{[x]+5}}{N_{[x]}}.$$

(*c*) Reversionary Bonus calculated upon Sum Assured and previous Bonuses (Compound Reversionary Bonus), with Interim Bonus at the same rate after first five years :—

$$P'_x = 1\cdot05\left\{\pi''_{[x]} + \frac{\cdot01}{a_{[x]}} + \cdot00125\right\}.$$

$$\text{where } \pi''_{[x]} = \frac{1}{N_{[x]}} \times \left\{\begin{array}{l} (M_{[x]} - M_{[x]+5}) + (1+5b)(M_{[x]+5} - M_{[x]+10}) + \\ \quad (1+5b)^2(M_{[x]+10} - M_{[x]+15}) + \text{etc.}(=\text{Sum} \\ \quad \text{Assured and Declared Bonuses.}) \\ + b(1+5b)(R_{[x]+5} - R_{[x]+10} - 5M_{[x]+10}) + \\ \quad b(1+5b)^2(R_{[x]+10} - R_{[x]+15} - 5M_{[x]+15}) + \\ \quad \text{etc.}(=\text{Interim Bonuses.}) \end{array}\right\}.$$

The calculations should in all cases be made at a rate of interest which the Office has a fair prospect of realising in the future; and that rate should certainly not be lower, as is sometimes said, than the rate employed for non-profit business, except perhaps in the one case of an office distributing according to the contribution plan. The method of valuation adopted by an office may have the effect of entirely distorting Bonus results, even when the premiums have been loaded to provide certain fixed additions as above indicated; but to enter fully upon this part of the subject would lead quite away from the title of the present paper, and perhaps it is sufficient merely to call attention to the danger.

Premiums reduced by Anticipating Bonuses.

Mr. G. F. Hardy (*J. I. A.* xxxi. 261) discussed the subject of 'the Use of Scales of Premiums reduced in anticipation of future Bonuses,' and pointed out that the adoption of such tables had become common in recent years, and that their use involves the consideration of such points as :—

(1) The Basis upon which the reductions should be computed;

(2) The Reserves attaching to the Policies;

(3) The course to be adopted when the profits exceed or fall short of the anticipated amount; and,

(4) The manner in which the calculations are affected by changes in the rates of interest and mortality.

The Premium rates should, as the title of the paper implies, be based upon the Full Profit rates of the Office, from which the value of the Bonus anticipated should form a deduction. It was pointed out that the greater the rate of interest assumed in computing the annual reduction, the smaller would be such reduction, and accordingly the rate employed should not be less than that earned by the Office upon its funds—say $4\frac{1}{2}$ per cent. or the rate at which the Office is willing to grant policy loans. On the same principle the Table of Mortality adopted should be Select, or should at least give a somewhat more favourable rate of Mortality than the average experience of the Office.

If a *Constant Cash Bonus* be anticipated, and if Interim Bonuses are given, the reductions of premium become merely loans at interest repayable out of the Bonus when declared; or, in event of death, out of the Interim Bonuses. If, however, the Cash Bonuses be payable at the end of the 5th, 10th, etc., policy years, with no Interim Bonuses, and the proportion anticipated be KP'_x, the value of these bonuses may be represented by the series:—

$$KP'_x\left\{\frac{5D_{x+5}+5D_{x+10}+\text{etc.}}{D_x}\right\}.$$

The annual reduction will accordingly be

$$\frac{KP'_x}{a_x}\left\{\frac{5D_{x+5}+5D_{x+10}+\text{etc.}}{D_x}\right\},$$

or, approximately . . . . . $\dfrac{KP'_xN_{x+2}}{N_{x-1}}$,

the last expression being got by the ingenious assumption that

$$5D_{x+5}=D_{x+3}+D_{x+4}+D_{x+5}+D_{x+6}+D_{x+7}\text{; etc.}$$

If Bonuses be declared as *Simple Reversionary Additions* to the Sum Assured, then if no Interim Bonuses are payable, and b = the annual rate of reversionary bonus anticipated, the reduction of premium will be given by the formula:—

$$\frac{5b(M_{x+5}+M_{x+10}+\text{etc.})}{N_{x-1}},$$

while the additional reduction, in event of an Interim Bonus of b' per annum after the first five years, would be:—

$$\frac{b'R_{x+5}-5b'(M_{x+10}+M_{x+15}+\text{etc.})}{N_{x-1}}.$$

Considerable difference of opinion seemed to exist as to whether *Compound Reversionary Additions* (the formulas for which are also given by Mr. Hardy) could legitimately be anticipated, the ground

of objection being that, as the Bonuses do not remain attached to the Policy, they cannot be said to earn 'bonus on bonus.' Such Compound Bonuses are most frequently earned from surplus interests; and if the reductions are computed by assuming a high rate of interest and light mortality, surely ample provision is thus made for the compounding of Bonuses, so that Policyholders have a fair claim to the equivalent of the larger benefit to which they would be entitled if they chose to enter the Full Profit class.

When such reduced scales of premiums are adopted, it is usual to reserve to the Office the right to increase the annual Premium, or to restrict the Sum Assured, in event of the declared rate of bonus falling short of the rate anticipated; while, if the declared rate exceed that anticipated, the Policyholders get the benefit. The rates of Reversionary Bonus anticipated in practice run from £1 to £2 per cent. per annum, so that there is a likelihood of there being Additional Bonuses in some cases, and a probability of Defective Bonuses in others. Mr. Hardy recommends that Additional Bonuses should be allotted according to the ordinary method adopted by the Company; but indicates that the Sum Assured is the only convenient function on which to operate should the Declared Bonus prove defective. If the Bonuses should continue defective for many years, a serious decrease in the Sum Assured might result; and it would therefore seem to be judicious to leave a considerable margin between the rate of bonus anticipated and the rate likely to be declared, so as to avoid the possibility of disappointment and distress amongst Policyholders in the future.

Changes in Policies.

After a Policy has been in force for some years, the Office may be requested to transfer it to another class and to adjust the premium accordingly. Should the change involve the payment of a larger premium during a shorter term, it must be assumed that the Policyholder is in good health, and, in his own interest, wishes to avoid the necessity for payments in the later years of life. If, on the other hand, he wishes to pay a smaller Premium over a longer term, the *Office* should insist on having some evidence of his good health, although it may be unnecessary to obtain a formal medical report in all such cases, because a reliable agent may be fully acquainted with the circumstances, and may give a satisfactory certificate. If, for example, the holder of an ordinary Whole Life Policy should desire to restrict the payment of premiums to m years, the change may be effected on payment during the shorter term of the premium, $\frac{P_x \mathbf{a}_{[x+n]}}{\mathbf{a}_{[x+n]:\overline{m}|}}$, where $x+n$ represents the age (frequently taken *last* birthday) at the date of change.

General Principles.

The change most commonly desired is that from a Whole Life Policy to an Endowment Assurance; and a full discussion of this section will probably indicate clearly the points to be kept in view when such alterations are being made. Suppose that the Whole Life Policy was effected at age x, that it has been in force for n years, the next Premium being just due, and that the request is made to alter it into an Endowment Assurance payable at age $x+n+m$. In the case of a Policy without profits, there are three ways in which the alteration may be effected:—

Whole Life to Endowment Assurance.

First. Accumulate at interest, the difference between the premium the Policyholder would have paid for an Endowment Assurance for $n+m$ years at age x, and the premium actually paid; and charge this amount either (a) as a single payment, the future annual premium being $P_{x:\overline{m+n}|}$, or (b) spread over the remaining duration of the policy.

$$(a) \quad (P_{x\,\overline{m+n}|} - P_x)(1+i)S_{\overline{n}|} = \left\{\begin{matrix}\text{Single Payment}\\ \text{on conversion}\end{matrix}\right\}.$$

$$(b) \quad P_{x\,\overline{m+n}|} + \frac{(P_{x\,\overline{m+n}|} - P_x)(1+i)S_{\overline{n}|}}{\mathbf{a}_{x+n:\overline{m}|}} = \left\{\begin{matrix}\text{Future Annual}\\ \text{Premium}\end{matrix}\right\}.$$

It is often difficult to convince a Policyholder that this method is unfair to the Office. As explained earlier in these notes, the risk which an Office runs, and which must be paid for year by

year, is not the sum assured, but the sum assured less the Reserve value. The risk under a Whole Life Policy therefore differs materially from that under an Endowment Assurance, because the reserve in the latter case is, from the commencement, greater. Accordingly there is a smaller sum taken out of the Endowment Assurance premium each year to meet current risk, and after a few years the difference thus caused by the greater risk incurred under Whole Life Policies, is considerable, and the payment of the accumulated difference between the premiums becomes inadequate. If, however, a rate of 5 per cent. be charged for accumulation, it will be found that the method may safely be followed during the first eight or ten years in which the Whole Life Policy has been in force.

Second. Charge the Office Premium for an Endowment Assurance of m years at the present age, less the Reserve Value of the Whole Life Policy spread over the duration of the new assurance, *i.e.* charge an annual premium of

$$P_{x+n:\overline{m}|} - \frac{{}_nV_x}{a_{x+n:\overline{m}|}}.$$

Under this method the Office makes a distinct profit, because expenses in connection with (1) Medical Examination, (2) Initial Commission, and (3) Renewal Commission on the quantity $\frac{{}_nV_x}{a_{x+n:\overline{m}|}}$, are not incurred, although all these items are provided for in the premium, $P_{x+n:\overline{m}|}$, introduced into the formula. The method therefore deals somewhat strictly with Policyholders, though it may be argued that the Office is entitled to compensation for the additional trouble.

Third. When the change is effected, the Whole Life Policy Reserve must be augmented to make it equal the Reserve for an Endowment Assurance taken out at the same age. The difference between the two reserve values should therefore be paid by the Policyholder, either in the form of a single payment, or as an annual sum spread over the remaining duration of the Policy, *i.e.* :—

(*a*) Single payment $=({}_nV_{x:\overline{m+n}|} - {}_nV_x)$, the future annual premium being $P_{x:\overline{m+n}|}$; or

(*b*) Future annual premium of $P_{x:\overline{m+n}} + 1{\cdot}075\frac{{}_nV_{x:\overline{m+n}|} - {}_nV_x}{a_{x+n:\overline{m}|}}$.

This is probably the most equitable method of dealing with the question, and it may be applied in all circumstances. The only point to be kept in view is that the single payment $({}_nV_{x:\overline{m+n}|} - {}_nV_x)$ contains no margin for expense, and, if commission be payable, a

loading would have to be introduced. In adopting the method in formula (*b*) such expenses would almost always be incurred, and provision has therefore been made for them by adding $7\frac{1}{2}$ per cent.

When the policies are "With Profits" the question becomes slightly more complicated, and depends upon the method of distribution. The first method, with the limitations referred to, holds under almost any form of distribution. Under the second method, if the Bonuses take the form of simple reversionary additions, existing Bonuses must either be cancelled, and their value added to ${}_nV_x$ in the formula given—an unsatisfactory course to the Policyholder,—or the increased value of the Bonus must form a deduction from ${}_nV_x$; *i.e.* if the declared Bonus be B, the formula would become

$$P_{x+n:\overline{m}|}-\frac{{}_nV_x-B(A_{x+n:\overline{m}|}-A_{x+n})}{a_{x+n:\overline{m}|}}.$$

If, however, the Bonus take the form of a compound reversionary addition for each premium paid, this method may be applied very simply thus:—

$$P_{x+n:\overline{m}|}(1+B)-\frac{{}_nV_x+BA_{x+n}}{a_{x+n:\overline{m}|}}.$$

Further adjustments are necessary should the change be effected between two periods of Bonus distribution, when allowance would have to be made for the difference in value of the accrued bonuses; also if Policies newly effected should not participate until several premiums may have been paid.

The third method above mentioned may be readily modified to meet all circumstances.

Past and Future

With some Thoughts on Heredity

BEING

THE INAUGURAL ADDRESS FOR THE SESSION 1898-99

BY

SPENCER C. THOMSON, B.A. CANTAB.

MANAGER AND ACTUARY, STANDARD LIFE ASSURANCE COMPANY

HONORARY PRESIDENT OF THE SOCIETY

Past and Future

With some Thoughts on Heredity

EXACTLY twenty years have elapsed since I first had the honour of addressing the members of the Actuarial Society as their Honorary President, being then but on the threshold of my official life.

Again ten years later I once more occupied this chair.

And now after the lapse of another ten years, as my professional career draws somewhat near its close, and you have again kindly asked me to become your President, there comes on me in meeting you at the beginning of your session for the purpose of offering to you a few words of welcome, a desire, on the one hand, to look back over the past—to get out of the trees, as it were, and see the forest,—and on the other, already throwing loose the trammels of daily routine, to turn in the forward direction with an endeavour to peer some way into the future and see what is in store for us there.

I will accordingly endeavour to ascertain in what way our science and the great practical businesses built upon it—and to promote which actuarial science mainly exists—have been tending during these more recent years, and, by carrying on the lines in the same direction, to make some forecast of the conditions that will prevail when you, who are entering on the actuarial profession, in your turn take the helm of management.

In the main fundamental principles underlying the science of the actuary, change indeed is hardly possible.

The leading factors of *interest rate*, *expense rate*, and *death rate*, along with the less frequently involved factors of the probabilities of marriage and of issue, and the general conditions, whatever they be, attached to life office contracts, must always form the basis of our calculations; and though changes are taking place from day to day in the values of each of these elementary data, no great cataclysm has occurred which renders unstable the structures which have been reared upon them.

But these changes of value, though not undermining the actuarial fabric, will be found, when looked at more closely, in many instances to require attention and to involve important

and interesting consequences; while, in the case of life assurance, other outside circumstances unconnected with the elementary bases of our calculations, or the conditions of the assurance contract itself, are further tending considerably to alter the character of the business.

And restricting my view on the present occasion to questions bearing upon the ordinary business of life assurance, I would here propose to examine, in detail, each more important factor upon which the structure depends, and then to take a general glance at the position as a whole.

In the first place, the question of *interest*, or the return for the use of money, being probably the factor least under the control of those who attend to the affairs of an office, is also probably the most important one of all, and that in which the most serious changes—changes still going on—have taken place in these later years.

In the earlier years of life assurance, and up to nearly thirty years ago, the aggregate funds of life offices were comparatively small, and the Boards of Directors of most of the offices rarely looked outside the British Isles, often not outside Great Britain, for investments in which to place them. Nay more, the Directors of Scottish offices seldom found it necessary to send the moneys they had accumulated furth of Scotland. An average rate of rather over four per cent. was secured on loans over fee-simple land in Scotland, and a half per cent. higher on improvement loans repayable by rent charge and on loans on life-interests in entailed estates.

The security for such loans as a general rule kept gradually improving through increase in the values of the properties pledged. The investment of the funds of a life office was in those days, therefore, a comparatively simple affair, while the post of law agent to a progressive office was a lucrative one. Matters to-day are very different.

In consequence of decrease in the value of broad acres in most parts of the United Kingdom, the loanable value of the land has diminished; while at the same time, owing to the enormous increase of capital which the beneficiaries for whom it has been set aside, or those providing for them, require to be safely placed, the sum available for this description of investment has grown larger, with the necessary consequence—the case being one of supply and demand—that the rate of interest on first-class loans secured over land in Scotland and elsewhere in the United Kingdom has fallen very considerably—as much certainly as three-fourths of one per cent. per annum, or even more—in the last thirty years.

But other elements remaining the same, if the rate of interest

returned on the funds of a life office falls, either the scale of premiums must be raised or the profits from the margin between the estimated and the actual rate of interest (and of which the rate earned is therefore a determining factor) must diminish or disappear altogether, with ultimate danger to the payment of the sum assured and consequently to the stability of the office if the downward course is carried still further.

Now, naturally enough, no Board of Management likes to see the profits of the business in which it is engaged curtailed without real necessity, much less to encounter any risk of the stability of the Company being endangered. The natural course for the Directors of life offices was therefore to inquire whether investments could not be found in some other practically safe forms of security, yielding a higher return than had come to prevail for loans on broad acres. Of course the old epigram of the Duke of Wellington that high interest means bad security was quoted. But the fallacy lurking in the general application of the maxim was soon discovered. The rule only really applies to investments offering under similar conditions. The available supply of capital on the spot or the character of the investment—such for instance as that the capital can only be claimed back after a number of years, or by instalments—and other considerations have an effect on the market, irrespective of the safeness of the security itself. Once it was realised that there were other good securities to be had, and at better rates, outside the usual range of life office investments, the offices one after another began to avail themselves of the opportunities which presented themselves.

These were mostly in two directions.

Firstly, in certain of the British colonies and dependencies, and in some foreign countries, where, owing to their later development, and to the severe competition with older civilisations which has stimulated them to a more rapid evolution than would have been the case had they been left to work out their own history without competition with more advanced neighbours, the financial requirements of the population are greater than in older settled countries, while, at the same time, the accumulation of capital and the supply of money ready for safe and permanent investment for provident purposes is not so large as it is at home. Investments under this head are for the most part restricted to government securities, loans on mortgage of property or rates, and first-class railway and harbour bonds.

Secondly, in certain British Stock Exchange securities which had previously been considered rather outside the sphere of investment of life offices, but which if well selected and carefully watched, and provided too large a sum is not placed in any one invest-

ment, have been found to afford a useful outlet for a certain proportion of the funds of a life office.

The selection of investments coming under these two classes demands both judgment and wide knowledge as well as access to special sources of information by boards of directors; besides which, every investment requires to be watched with care and reviewed at much shorter intervals than was necessary in former years. And more especially is this so in the case of Stock Exchange securities, regarding which the information must be continually brought up to date and reviewed by those responsible for the management of the office.

Such a system of dealing with the investments of a life office would even a few years ago have been considered, and indeed would have been, unnecessary; but in these days things change rapidly, and every institution must adapt itself to new lines of development or be outstripped in the race.

Of course, as I have said before, great caution is required in laying out money on these newer classes of securities, and there is undoubtedly room for abuse; but with careful management little loss should occur, and this, if spread over the whole return from the funds, should not have any material effect on the interest income. At any rate, with ordinary care much greater benefit should accrue to the assured from a somewhat more extended category of investments than if the money were all placed in the securities of thirty years ago.

I do not, of course, mean that all the funds of any life office are, or should be, placed in these new classes of securities—most offices have considerable sums lying out on the old investments at low rates,—but the new descriptions of security give an outlet for the more recent accumulations and tend to raise the average rate over the whole aggregated funds of the office.

How long and how far the striking out of these new methods of investment will arrest the falling rate of interest on life office funds is a very difficult question, and one on which the views of those best entitled to express an opinion differ. Some consider that the old rates are gone for ever, not only on the same classes of securities as were formerly in vogue, but, taking an average, on all the securities in which it is proper to place the funds of a life office; and further, that the return for money will continue to fall lower still. To meet this expected deficiency a few offices have already adopted 2½ per cent. as the highest return which they can safely expect to realise on their aggregate funds, with a sufficient margin over for profit and contingencies, and are making their valuations accordingly.

The offices who have taken this course, however, keep their funds for the most part within the United Kingdom, limiting their

choice of investments at the same time a good deal, and if they continue to follow this course the change is probably a judicious one,—but for those others who accept on their merits all securities, whether situated at home or abroad, that are up to a certain standard of fitness—and many offices have of recent years taken power to do so which they did not previously possess—the drop must at any rate be much more gradual. What the ultimate downward limit may be it is not easy to predict, save that the rate cannot fall below the minimum return, whatever that may be, at which the investor will consider it worth while to risk his money out of his own keeping rather than lay it by in his chest. But before this point has arrived the scale of premiums will have been increased, if the equilibrium of the office is to be maintained; and, indeed, it is quite possible to conceive an ultimate limit of premium or of annuity where the interest element is altogether excluded from the calculation and the rates of premium and of annuity are ascertained by the help of the probabilities of mortality alone, with some loading added for expenses.

But keeping to the situation as it is at present:—*On the one hand*, we see a vast and ever-increasing quantity of capital all over the world, gathered from rich and poor, seeking investment, speculative or provident. *On the other*, there is a large portion of the world still unexploited, where undoubtedly much capital will be required and spent, and much wasted, before—if ever such time arrives—the whole globe is developed to its utmost capacity.

As regards the aggregation of capital it should be remembered too, as a counterpoise, that if the rate of interest rules low, accumulation will go on less rapidly than before, while previous accumulations will also, in many instances, be dissipated by individuals, who in order to increase their income sink their savings in purchase of an annuity, instead of living upon the mere interest from them as they would in more instances have done if the return from the capital had been greater.

My own impression is that the offices which with pains and judgment place a portion of their funds in securities of the wider class I have alluded to will succeed in maintaining an average rate of nearly, if not quite, four per cent. for a number of years to come, and that without undue risk, if proper precautions in selecting and watching the investments are observed.

It must not be forgotten, however, that a fall of even one-half per cent., in the return on large sums, makes a very considerable change in the situation, for one-half per cent. on a fund of five millions is £25,000 per annum, making in five years, without interest, £125,000—a very considerable item undoubtedly when deducted from the sum divisible as profit at the end of a quinquennium amongst policy-holders and shareholders.

Whether this deficiency, which most life offices are experiencing

to a greater or less extent, can be made good in other ways, brings us to a consideration of the remaining factors I have alluded to, as forming the pillars on which the fabric of life assurance rests. And, next to the interest rate, the *ratio of expenditure* has probably suffered the greatest variation of late years—though it might naturally be looked on as an item that should be fairly well under control. On the contrary, however, it has in many cases gone on increasing rather rapidly, thanks to the competition of certain foreign offices whose system is to lay great stress on the acquisition of new business, without taking much heed what representations are made to secure it, or whether the assurances are maintained in force.

To produce the desired result commissions ever larger, and huge sums for travelling and other expenses of inspectors, and for advertising and suchlike, fall upon the first premiums on short-lived policies and greatly augment the expense ratio. The consequence of this method of business is that most offices—that is, those not having a special clientêle—without adopting some of the more questionable tactics of their rivals, are more or less forced by competition to expend larger sums in keeping their names before the public and in the acquisition of new business than would have been necessary had the old system of competition been allowed to continue. Such a manner of conducting a serious business cannot, one would think, always prevail, but it will do so probably until some catastrophe occurs arising from the recklessness which a mad pursuit of business, at all cost, engenders, unless, indeed, the public who support such a system should become wiser and more discriminating, as well as more alive to the fact that it is to their interest to keep up their policies and not to drop them, and that it is they really who pay for a heavy expenditure; but of this, I confess, I have not much present hope. The ratio of expenditure on the permanent indoor establishments of most British offices has not, I think, increased of late years, but rather the reverse, which, if true, tends to confirm the conclusion that, with perhaps a few exceptions, the lead towards an undue expenditure comes from outside the British Isles.

Then there is the *rate of mortality*, which is the factor more particularly associated in the popular mind with actuarial science and the business of life assurance.

As most of you are aware, there is an important investigation going on at this time into the rate of mortality which has prevailed amongst the annuitants and the lives assured in a number of life offices during the thirty years from 1863 to 1893, in continuation of the previous investigation on similar lines terminating at the former date. The mortality rate of annuitants will probably show some improvement, these being mostly drawn from a class who

lead temperate lives, with a high standard of comfort and freedom from anxiety. But as regards the mortality amongst assured lives I do not anticipate any material change as compared with the results of thirty years ago. For though the expectation of life for the whole population has considerably improved during the period in question, this has arisen for the most part by reason of a diminished death-rate in the years of childhood—with which the life offices are not much concerned—and amongst the non-assuring population, or at least the population who assure with offices doing industrial business, and there is little indication that the death-rate has decreased amongst the ordinary class of policy-holders. Indeed, the strain and stress of modern life and the struggle for existence tell heavily, medical men are agreed, against the very class most given to life assurance; besides which the benefits of life assurance are everywhere more fully recognised than of old, and most of all by those persons who are on the borderland of eligibility, while competition tends in some instances to make offices less particular or careful in their selection than would otherwise be the case. Then, again, policies on the lives of persons in failing health, instead of being dropped or surrendered, are more often than formerly maintained through the agency of reversionary societies or by other means. The tendency is thus, it appears to me, rather towards a stationary or increasing than to an improved death-rate.

In one direction, however, a change has been introduced by the use, in some quarters, of select life tables, the effect of which is to give the public the immediate benefit, in the premiums charged, of profit from selection, instead of leaving it to fall in to the general fund divisible at the investigation period, as happened when premiums were founded, as is still sometimes the case, on tables representing the mortality of the community at large, or of some particular section of it. The result of this plan is that practically profit and margin for contingencies can, in a mutual office, only be sought for in the excess of interest realised over the rate assumed in the office calculations and from any saving of expenditure from the loading added to premiums (miscellaneous profits in these days counting for very little). In a proprietary office there is, in addition, the shareholder's guarantee to fall back upon, entitling them to cut the margin rather finer, should they see fit to do so.

Another feature of consequence in late years, when considering the question of mortality, is the gradual improvement which is taking place in the death-rate of tropical countries, which, though not so great as many persons, and especially those themselves living in the countries, seem to think, is yet considerable in certain of the more favourably circumstanced localities where sanitary

improvements have been carried out, change of residence is easy, and the habits of life are settled. These improved conditions have led to a reduction being made in the extra premium charged for foreign residence in many parts of the world, and still more in the rate for whole-world policies, which improved means and opportunity of locomotion have made increasingly popular.

On this point, indeed, I look for still further modifications consequent not on the more liberal view and wider horizon of boards of directors and officials, but on changes which are taking place outside our business. Already many offices give the privilege of world-wide residence to persons having *no* intention of proceeding abroad. But in these days of rapid communication on the one hand, when almost every one travels, and of improved conditions of life in those places usually visited by travellers on the other, I think we shall see a progressive leniency in the rating for residential extras, possibly ending some day in there being one uniform rate of premium applicable to the whole world for all assurers.

Statistics—notwithstanding the improvement in the death-rate that I have alluded to—do not yet, however, by any means justify such a course for an office with a mixed constituency, but in offices confining their business to a special profession or class the plan would work well enough and be fair all round.

Then as regards general conditions.—The great aim of most offices nowadays is to simplify these as much as possible or to abolish them altogether. It is indeed one of the strangest things in the whole history of the business of life assurance how long it took to permanently impress on the minds of boards of directors and others responsible for the conduct of offices that *the business of life assurance is to assure*, and that concessions at comparatively little expense or risk could be made on many points with a benefit to the body of assured lives and to the whole system of life assurance out of all proportion to their cost.

Nowadays the *Conditions* of many offices are turned into *Privileges*, and are so completely protective that little or nothing remains to be done. These concessions to the assured are not, however, made, though the public are apt to forget it, without some cost to the office.

On a review of the whole of the factors I have referred to, I cannot see that there is any one item from which increased profits in the future can be expected, to counterbalance the falling rate of interest which is so powerful an element in determining profits; and there is to my mind as a consequence every probability that the near future will see the periodical surplus of offices diminish and in some cases too the rates of premiums increased.

But perhaps the greatest change which has come over life business of late years is, after all, the decadence of the old whole of life premium plan and the substitution for it, to a great extent, of the plan of terminable payments, or, more frequently still, of the *Endowment Assurance plan.* Although the old whole of life system has a great charm for those who were educated in its principles, and saw a large and steady business effected under it, it cannot but be confessed that the other classes I have mentioned suit the circumstances of many people better, for in these days such is the competition in all occupations that the young are ever growing up and treading on the heels of the old, and it may be ousting them from their posts of vantage, in which circumstances it is of great benefit to have the premiums completed before the date of retirement, or still better to have the policy money in hand and yielding a return. Of course such advantages are not got for nothing—nothing in this world worth having that I know of is—and must be paid for, but a little more self-denial in earlier years is, for many, well recompensed by the additional comfort secured for the later years of life.

Another reason why endowment assurances are more popular now than formerly is that life policies for pure family provisions are in many cases no longer so necessary as they used to be. This is attributable to the fact that already life assurance and other plans of saving money have so far done their work that when a marriage takes place there is, much more commonly than of old, on one side or the other, if not on both, a fund in existence, derived very possibly from the proceeds of a policy on the life of a member of a previous generation, which protects the family at least against the risk of absolute want, and so renders a new assurance less of a necessity than it would have been when the accumulated wealth of the country was not so great as it now is.

The demand for endowment assurances too is, from the point of view of the offices, more desirable in one way, viz. that their currency being for a shorter duration there is less necessity to take into account, in the calculation of premiums and the valuation of policies, the rate of interest which will be likely to prevail after a remote period of years, while the benefit of selection, when this is not given away in calculating the premiums, has a greater weight than in the case of policies for the whole term of life.

The subject of the address which I gave from this chair in 1877 was "Selection"—selection, that is, of lives *by* the office from amongst those seeking admission and *against* the office by persons wishing to withdraw, or to purchase annuities from it. Needless to say, both sides have been busy in these years, the public to take all advantage possible—sometimes by means hardly fair—of the benefits of life assurance which have become every year better

known, and the offices to guard themselves, by more searching tests and by eliciting fuller facts, against the admission of under-average lives. Here of course the medical officer's functions are of great importance, and increased attention is given to many personal points which in old days were overlooked or which there was not as good opportunity of investigating as there now is. More especially I may mention the examination of urine, which is so important a matter in diagnosis at the present day, and which—often to the chagrin of boards of directors and managers, sometimes even to their scepticism—leads to the rejection of many lives apparently quite healthy, some of which attain to a respectable old age, diagnosis notwithstanding.

Far be it from me to deny all urine tests, but in my humble judgment there is something still to be learnt by the Medical Faculty on this head, something in the way of discrimination to take the place of the out-and-out rejection of applicants tainted by this flaw, which is the advice of some medical officers.

It is sometimes said that the selection of lives in the old days, when the only form gone through was the perambulation of the board-room table by the applicant under the practised eye of each Director, was as effective as the present medical examination. Such a system would in these days be impossible, and under it doubtless many lives were accepted with latent flaws in important organs not discoverable by outward appearance. But these flaws being unknown to the applicants themselves no selection against the office resulted, and on the other hand many doubtful lives were rightly excluded, by reason of their presenting a general appearance of delicacy or of want of vitality, such as are daily passed, in country districts more especially, because their organs are at the time pronounced sound and free from active disease; indeed, I am disposed to think that the two systems would produce equally good results.

This train of thought leads us on to the relative importance of personal health, history, and habits on the one hand, and of family history on the other, in determining a man's future lifetime, which has long been a subject of discussion.

Thirty years ago very great stress was laid on family history in the selection of lives, and it is so still with some examiners, but the more modern view tends, I think—and it so presents itself to my mind—to attach a much larger importance to the personal element, after the applicant has attained full manhood.

Of course the two depend to some extent upon one another—weakly or tainted ancestors produce for the most part descendants of like kind; but I think that a proper selection can practically eliminate the under-average cases, and show as favourable a

mortality amongst lives selected from families with an unfavourable history as amongst others.

And this comes from the very fortunate fact that in all living things of whatever species, whether plants or animals, there is a tendency, under favourable circumstances, and unless the tendency is overborne by some stronger deterrent force, for the individuals to revert to what may be called the normal type, any departure from which normal type must either, from being an improvement on the old stock and of persistent character, establish itself as a new and higher species, or else, through being degenerate and therefore incapable of holding its own in the struggle for existence, fall out of sight and perish.

Consideration of these points involves the intricate but most interesting subject of heredity; and as this is a question which has of recent years engaged the attention of many learned and scientific men, and is also cognate to our own subject, I propose here to say a very few words about it, hoping they may lead some of my hearers to study it more deeply and to take an interest in the numerous inquiries and speculations which it involves, and with regard to which men of science are by no means yet agreed.

There can be no doubt whatever, I think, in the minds of ordinarily intelligent persons, that there is such a fact as *heredity*—that the family characteristics, mental and physical, good or bad, healthy or diseased, inherent in all living creatures from their birth, are the result of hereditary transmission like from like, or, in the words of the Bible, each after its kind.

The physical manner in which this is brought about is not yet fully ascertained, but it forms one of the most interesting chapters in the literature of modern research. The subject is far too intricate and technical a one to dwell on at present, and I would refer any who wish to study it minutely, to the works on Heredity of the eminent German scientist, Weismann, and of other writers, several of which are to be found in the library of the Faculty, to which you have access.

The great Darwin was one of the first to put forward a theory on the principle of heredity, but he did not propound it as a definite conclusion he had arrived at, but merely as a tentative hypothesis by which the facts of heredity might be accounted for.

According to his hypothesis, which he styled "Pangenesis," minute bodies which he called "gemmules," representing the qualities not only of the parents themselves, but to some degree of their ancestors also, are thrown off in immense numbers from all the cells of the body and congregated in the germinal cells. In this way every characteristic of either parent stock is, as it were, collected in the new individuality, though for reasons not fully explained they do not all have their full effect on the

young life, but some of them have a preponderating influence while others remain latent.

No proof, however, has been furnished of the existence and action of these gemmules, and the conception has now been practically given up.

The theory which holds the field to-day is probably that of Weismann, whom I have mentioned above, viz. that a permanent "germplasm" exists in every individual in which is contained the spark of life, that such is handed on practically unchanged to each individual at his birth, that the cells lie dormant until he reaches the procreative period, when they wake up and are ready to be passed on to the next generation, there to light up life, and, having lost nothing in the operation and gained nothing, again lie dormant until the maturity of that generation calls them forth once more. This theory Weismann has maintained with much skill and power, though not without much contention, and it must be observed there hangs on it the conclusion that no acquired character can be inherited—that no physical peculiarity, say the dexterity of a craftsman, no mental acquirements, such for instance as a cultivated taste for music, can be transmitted to offspring.

If such is the case, how comes any change or any progress in the world, if all the peculiarities of any stock are handed down unaltered from a primæval germ? What comes of the great theory of evolution which develops more and more the whole world of nature into something ever higher and better than what went before? "Variation" and "Natural Selection" are the means by which, according to Weismann, progress comes.

Of the immense number of plants or animals born from parents of the same species, he argues, the units do not exactly resemble each other but vary considerably, the variation being brought about mainly by the mingling of elements derived from parents brought up under somewhat different conditions. Of these units those which are best fitted to succeed in the struggle for existence survive, and in this way the race in the course of countless generations has made progress. The slightest variation is of use if it assists the individual to live in better harmony with its surroundings, but to be of permanent advantage to the species the variation must be *fixed*, that is, made common to the species and perpetuated in it, which by no means happens with every favourable variation. Just as in the human family not every man above the average in ability founds a line, but only when there is a staying power as well, imparted to the family by inter-marriage for some generations with wives having the same characteristics, or by original descent. The upward progress is generally by very slow degrees, almost indeed imperceptible, though every now and then, I am disposed to think, through some change of surroundings or some

lucky concourse of hereditary elements, a high step onward is made in the development of a family or species. The Jewish type of race and character, for instance, has survived unchanged for centuries, and yet they may very well, I think, have been evolved and fixed originally in the course of a very few generations living under abnormal and exciting conditions, and inter-marrying with one another only. The Scottish character similarly was, I think, modified with some permanence under the religious excitement of the seventeenth century, though, owing to change of circumstances and inter-marriage with persons not bred under the same influences, the severe type is wearing out.

The great achievements in science of the latter half of the century in which we live are sometimes spoken of as if brought about by some very sudden and inexplicable turn in the evolution of the human race. This, however, is an erroneous view. It is more like the truth to say that no elevation of the mental faculties of the human race is going on, that possibly even there is a retrogression.

What has been going on is a more rapid increase in the intellectual acquirements of mankind as a whole, due to the accumulation of knowledge by which each successive generation is enabled to start, without possessing any larger powers, from the platform to which its ancestors have climbed, each platform won offering higher problems for solution, together with better means and appliances for their investigation.

For my own part, I do not see that the causes of the variations in individuals are sufficiently accounted for if we exclude all action upon the germplasm from without. I do not mean that every physical accident that happens to the parent, every art or trick that he acquires, is handed on to the child; but it is to my mind very difficult to account for the progress of life upon earth from the humblest protoplasm to the most highly developed human being by the process of variation and selection alone, without the additional hypothesis that the variations are caused by some characteristic which the parent has acquired from without, and which, *under favourable circumstances*, he has the power to transmit. Indeed, a recent writer, who has the same doubts, maintains that it does not affect the theory of continuity to admit that decisive variations produced by environment or function may send their roots deep into the system, penetrating through the body to the reproductive cells themselves. For myself, I speak, of course, as a humble disciple only, and subject to all correction; but, however the variations occur, there can be no doubt that the types of plants and animals which survive in the struggle for existence are those which best suit themselves to their surroundings—or their environment, as it is generally called. In a state of wild nature, any abnormality, whether of plants, of the lower animals,

or of man, which does not assist in the protection of the species, at once tends to degeneracy; and if the species cannot hold its own in the struggle for existence, it decays and finally disappears.

In this way during the past ages of the world thousands of types, which could not adapt themselves to changing surroundings, have disappeared; and the same thing is still going on, new types slowly rising and others shedding their degenerate members or altogether disappearing.

"Are God and Nature then at strife?" says Tennyson in one of his noblest poems—

> "Are God and Nature then at strife,
> That Nature lends such evil dreams?
> So careful of the type she seems,
> So careless of the single life.
>
> . . . . .
>
> 'So careful of the type?'—but no,
> From scarped cliff and quarried stone
> She cries, 'A thousand types are gone:
> I care for nothing, all shall go.'
>
> . . . And Man, shall he . . .
>
> Who trusted God was love indeed
> And love Creation's final law—
> (Tho' Nature, red in tooth and claw
> With ravine, shrieked against his creed)—
>
> Who loved, who suffered countless ills,
> Who battled for the True, the Just,
> Be blown about the desert dust,
> Or sealed within the iron hills?"

And no one can study *Nature*, or understand the purpose in it, who does not fully realise what a recent writer has called the *silence of God*, in other words, the truth that Nature—*the Nature of Science*—reveals nothing of a final moral purpose, or of any purpose beyond progress, and is apparently utterly ruthless in its dealing with the world and all that is in it, and absolutely regardless both of the species and of the individual.

That there is another side to the picture—a side that satisfies the theological and moral, as the lines I have quoted appeal to the scientific, man—it was not possible for Tennyson's deep and double-sided nature to miss. He feels the need of something better and higher to justify the soul's aspirations, and alongside of his recognition of the crushing and apparently merciless power of Nature, movable neither by pity nor prayer, he offers up his hope, his creed, that for man, at any rate, there is some better fate—

> "That somehow good
> Will be the final goal of ill,
> *No* pangs of Nature, sins of will,
> Defects of doubt and taints of blood,

That *nothing* walks with aimless feet :
  That *not one* life shall be destroyed,
  Or cast as rubbish to the void,
When God hath made the pile complete,—

That not a worm is cloven in vain ;
  That not a moth with vain desire
  Is shrivelled in a fruitless fire,
Or but subserves another's gain.

Behold, we know not anything ;
  I can but trust that good shall fall
  At last—far off—at last, to all,
And every Winter change to Spring . . .

Behind the veil, behind the veil."

But it is rather of the Nature of Science, the inexorable heartless power, that I wish to speak.

What then, so far as we can trace it, is the end of all Nature's aims ? Nothing more, that we can see, than the continuance of the world's evolution by renewal of the individuals living on it, and their development, though slowly, and at times with retrogression, from a lower to a higher scale of being.

Every living thing, from the gnat to the elephant, from the lowest invertebrate up to man, is born, arrives at maturity, reproduces its species, and—when the offspring are mature and can shift for themselves—dies and disappears. This is the normal life.

In beings of the lowest unicellular type there is no such thing as death except by Violence, Heat, Poison, or the like. Reproduction is brought about by fissure. It is impossible to say which is mother and which is child ; both parts live on and are complete, and self-contained, if simple individuals.

But with complexity of structure came death into the world and all our woes, nor, *pace* Milton, is there any trace in scientific research of an Eden from which man fell by his disobedience, and into which death came to the human race for the first time. What, then, is death ? And is it a really necessary fate for all ? Is there anything inherent in man's self, in the bodies of all living creatures, which involves death as a necessary consequence ? Why must the organism wear out ? Can its essential parts not be renovated as with a man-made machine ? These are weighty questions and stir us to our innermost depths. And again, allowing death as the necessary lot of other created beings, may it not be possible for man—made in God's image, conscious of his own existence, having within himself a spark of the deity, and knowing by patient study of God's works both the evil and the good—so to modify his race as to render it perfect and immortal ?

I have said that with complexity of structure came death. Death indeed is no necessary concomitant of a complex vitality,

but it is of use to the species, and there cannot be the least doubt that the higher organisms as they are now constructed have for this reason acquired and contain within themselves the germs of death.

But how did it happen that when the humble or unicellular forms of life developed into the more complex or multicellular, they lost the power of living for ever? It arose apparently from the division of labour in the work performed by the different cells when the body of the animal became more complicated. Some of the cells then took up the work of reproduction, and others that of nutrition, these latter being called the Somatic cells; though in some of the lower animals it will be noted that the two functions are still sometimes mingled, the Somatic cells, as for instance in the case of the salamander, having yet the power of reproducing a lost tail or foot.

But with the growing complexity of species the cells became more differentiated from one another, and the Somatic cells came largely to outnumber the reproductive cells, with the result that the power of renewing large parts of the organism was lost, and that of reproducing the whole individual became concentrated in the reproductive cells alone.

It did not indeed follow from this differentiation that the Somatic cells were compelled to lose the power of unlimited cell-reproduction, although they could only give rise to cells of the same description as themselves. But as the fact of death seems to indicate that they have lost even this power, the causes of the loss must be sought outside the organism, that is to say, in the external conditions of life. *The reproductive cells* cannot lose the capacity for unlimited reproduction, or the species to which they belong would suffer extinction, and indeed it is pretty clear, whether or no they are reinvigorated and have new elements introduced from without, that these cells are of unending duration, while the Somatic cells have lost this power and have become restricted to a fixed number of cell generations.

Normal death could not take place among unicellular organisms, because the individual and the reproductive cell are one and the same; on the other hand, normal death is possible, and has made its appearance among multicellular organisms in which the Somatic and reproductive cells are distinct. Death is thus a restriction in the powers of reproduction possessed by the Somatic cells following from a limitation in the number of cell-generations possible for the cells of each organ and tissue. And this limitation in the number of cell-generations is brought about, it is argued, by natural selection; for death is beneficial to the species, as replacing old and worn individuals by new and perfect ones, though not an absolute necessity essentially inherent in life itself.

Now, what are the requirements of each species up to which

point the reproduction of the Somatic cells is of use, and it is consequently beneficial to the species that the individuals composing it should not die?

I have already said that the sole predicable purpose of Nature is the continuance and upward development of the species, so that it may maintain its place amongst others in the struggle for existence, or, it may be, strike out some new feature or characteristic that will aid it in getting a firmer grip on its position in the world than it had before—for woe be to it if it falls behind! Nature has no pity, and "the devil take the hindmost" is a true description of its ungentle ways.

The length of life, as you well know, in different animals is very varied, ranging from a few minutes to hundreds of years, but yet the purpose seems to be the same in all—the building up of the constitution—reproduction (sometimes a solitary act with death as its immediate termination, but more commonly extending over a period of years)—the rearing and education of the offspring, when this is not done vicariously, as in the case where the parent does not survive the reproductive act—and then the end.

Provided the cell-production goes on till these conditions are fulfilled, there is no longer use for the old and outworn individual, and he must go and be replaced by a new and fresh one.

The relative length of life of the different animals is, it will be found on reflection, the resultant of the circumstances and requirements of each species. A complex structure takes more time to develop than a more simple one. A late and slow breeder, like the elephant, for instance, requires a longer period of life at its fullest, so as to ensure that a sufficient number of the breed are produced to perpetuate the race; and if the life history of each animal is examined, it will be found that the normal length of life is a function of the various requirements involved in the perpetuation of the species, and of its maintenance without degeneracy or decline.

Take man. For about twenty-five years he is growing to maturity, for the next twenty he is in a condition to perpetuate his family to the best advantage, and for twenty-five more he is bringing up and educating them, and we thus have the seventy years of the psalmist, which may be called the normal or necessary life of man—necessary, that is, to the due and sufficient perpetuation of his race.

In reference to the human race, some interesting questions occur to us for investigation.

Why, if the normal span of man is seventy years, do so many individuals of the race fall short of it, in much larger proportion, apparently, excluding accidents, than in the case of other living beings, and to the injury, according to our argument, of the species?

Again, man being not wholly subject to the laws of Nature, but able to prevail against these and turn them to his advantage in many ways, can he not so work upon them as to acquire for himself the boon, or supposed boon, of a life very much more prolonged than the threescore and ten which the requirements of his own development and that of his offspring demand, if not of infinite duration?

The answer to the first question is, of course, obvious. Accidents there always must be, but besides this practically irremovable cause of death, man from living in an artificial state—that is, a state other than that simple state of nature in which the energies are wholly occupied in providing food and avoiding enemies—and being at the same time very ignorant of the effects which excesses of all kinds and improper nourishment have on his health, has corrupted his body, and at the same time made it a more easy prey, or it may be a more congenial camping-ground, for many deleterious and minute organisms that would not attack it if he were living a life of nature. Other animals are subject, no doubt, to attacks of disease, and death therefrom, but, except in the case of domesticated animals brought up under unnatural and unwholesome conditions, their bodies are usually in a state of perfect health, and able to withstand the ravages of many illnesses from which, if it were not so, they would, like human beings, rapidly succumb.

The constant struggle for existence keeps the race up to the best standard attainable, and weeds out those members whose constitutions are liable to disease—that is, those whose bodies are poorly developed and afford congenial soil in which parasitic diseases can take root. There is in Nature, as I have said, under favourable conditions, great recuperative power; but if from unfavourable change of environment or the growing competition from some new species that has arisen, the whole race falls off in tone and repelling power, it must quickly drop away and disappear to make room for some other more vigorous one.

The life of man is highly artificial, but he has also more power either for good or evil than any of the lower animals. For while much that is deleterious to him is the outcome of his own inventions and of the mode of life he has from choice or necessity adopted, he has also, unlike any other animal, the remedy in his own hands, though it is only of late years that he is wakening up to its use.

In his savage state man was subject to the same inexorable laws of Nature as all other created beings. He forged ahead in the struggle for existence, and was at first little more than a rude animal, but a hairbreadth beyond the apes in intelligence, and with only the germ of self-consciousness developed in him. The struggle for life kept him vigorous and healthy, and he had no more ailments than the brutes.

Gradually he acquired arts and luxury, and with these corruption set in; and although to some extent the necessity of a healthy mind in a healthy body was known to some of the older races, their knowledge of the dangers of excess and of the causes of disease was on the whole very limited.

Indeed, it is only within the present generation that the study of microscopic forms of disease, which find the human body a congenial soil, and the necessity of sanitation to purge them away, has become a gospel—a gospel which has all along been taught, had there only been eyes to see and ears to hear, and is still being taught at this very hour, in Nature's usual and seemingly heartless manner.

Fortunately a race has great recuperative power, and man, not like the animals the subject of blind fate, but conscious of his existence and with knowledge of the universe in which he is placed, and with the power in his own hands and responsible for his own courses, no longer by *natural* selection, but—like God knowing good and evil—by the *deliberate* selection of his own choice, by giving play to favourable variations and removing the cause of disease and suffering, by creating new and healthier surroundings, can surely assist towards a higher and healthier development of his race,—and why not a longer span of life than has ever, save in mythical times, been accorded to man before?

To the pure *animal* no doubt the limit of existence is determined, as I have already stated, by the mere necessity of continuing its race. But may there not be some higher necessity in store for man in the limitless intelligence of the designer of the natural universe, in the growing complexity of science and the difficulty of mastering in an ordinary lifetime anything more than some one little page of it, though the aspiration to do so increases ever more and more; may it not be that, the struggle with brute Nature being gloriously ended, man conscious and godlike may, with greater powers and longer time in which to learn and with the stepping-stone of knowledge previously acquired to spring from, serve his race and his Creator better by a healthy and vigorous life drawn out through a longer span of years?

And what of those who fall out by the way? Are we to let them perish in accordance with Nature's savage law and the apparent intention of the world's Creator, or, lifted up by the self-consciousness and sympathy for others which, whether mysteriously from within or sent by the Deity from without, has sprung up of late years and been made patent to all by the noble example of the Founder of our religion, are we to take them up tenderly and care for them and nurse them into vitality again?

I ween we cannot but do this last. A massacre of the weakly and suffering would purge the race no doubt and more quickly

restore its animal vigour. But at what cost? At the cost of the new and higher development which is springing up and leavening the world and by killing which greater injury would be done to the race, by cutting off its topmost, most heaven-pointing shoot, the new life which has come among us, the new gospel—not the old creed of the struggle for existence, and devil take the hindmost, which is all that science teaches, but the new law of love and help, which, though not over-riding or supplanting the old inexorable law of Nature, which has been the world's schoolmaster, has after millions of years come, almost in our own day, to alter existence and to make it happier and brighter even if at first it arrests a little the completer development of the race.

And while there is on those who are healthy and vigorous and are the future hope of the race an incumbent duty to work and help on the task which brute Nature, now that we have found the key, so plainly preaches, is there none on those who, whether from their own or from ancestral fault, have fallen behind in the race and have to be cared for by their more fortunate brothers? On their side too there must be some self-denial. Just as the new feeling that pervades the world forbids the neglect of those who suffer, so also it is not likely to put any prohibitive or restrictive rules upon their marriage—and in return for the compassion that is shown to them by protection in the struggle of life so should they, when their state is such that their offspring can only be diseased, have self-denial in the matter of marriage and not bring into the world beings foredoomed to suffer.

That the race will throw off the terrible incubus of suffering and disease and, by the combination which will come of knowledge and sympathy, overcome the thraldom which has overtaken it in that transition period it has been passing through, of knowledge without love, I myself have no doubt; though the struggle will be hard and many generations will pass before the victory is won,—once more to quote Tennyson:—

"The solid earth whereon we tread

In tracts of fluent heat began,
  And grew to seeming-random forms,
  The seeming prey of cyclic storms,
Till at the last arose the man;

Who throve and branched from clime to clime,
  The herald of a higher race,
  And of himself in higher place,
If so he type this work of time

Within himself, from more to more;
  Or, crowned with attributes of woe
  Like glories, move his course, and show
That life is not as idle ore,

But iron dug from central gloom,
  And heated hot with burning fears,
  And dipt in baths of hissing tears,
And battered with the shocks of doom

To shape and use. Arise and fly
  The reeling Faun, the Sensual Feast;
  Move upward, working out the beast,
And let the Ape and Tiger die.

. . . . .

So runs my dream: but what am I?
  An infant crying in the night:
  An infant crying for the light:
And with no language but a cry."

And this cry, what is it but a prayer, an aspiration for help towards a fuller knowledge of the universe and its Maker? *Laborare est orare*—"to work is to pray"—is an old monkish saying, meaning that if you aspire towards anything you will attain your object not by sitting in petition with folded hands, but by hard, honest, intelligent work, which is the means God has put into our hands for achieving the purpose we desire.

Let each of us then strive, with the poet's faith and trust, to add our contribution, great or small, to that knowledge with which man is building for himself a new world out of the secrets which have all along lain hidden in the bosom of the hills and of the valleys, for his finding in the fulness of time; or if we have not the gift of invention, let us at least by sympathy and appreciation aid, so far as we each may, the upward progress of life on our planet, standing in the vantage-ground secured for us by past generations of workers, and making of them stepping-stones ever upwards towards higher things, which, *unless we forget*, is the manifest destiny of us all.

Some Notes on
The Selection of Lives for Assurance

BEING

THE INAUGURAL ADDRESS FOR THE SESSION 1898-99

BY

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Some Notes on
The Selection of Lives for Assurance.

GENTLEMEN,—Allow me in the first place to thank you most sincerely for the honour which you have conferred upon me, in electing me President of the Actuarial Society for this Session. A consideration of the long list of those who have been my predecessors in the Chair, makes me all the more sensible of the honour, and it is therefore with diffidence though with great pleasure that I accept the post. While my residence out of Edinburgh will prevent me from presiding at as many ordinary meetings of the Society as I should like, I think I may assert with confidence, that no one takes a deeper interest in its progress. I have been a member of it for thirty-three years, and have experienced the varied benefits which a Society conducted as yours has been, is able to bestow, and to which many here are largely indebted for assistance in their career. The main benefits to which I refer are (first) the stimulating effect of intercourse with men desirous to raise the standard of our profession, founded as it is on the threefold basis of exact science, true benevolence, and honest business principles—a combined foundation which few professions are able to claim; (second) the information and culture which are gained from the perusal and study of the papers read to the Society; and (third) what is perhaps more valuable than either of the other two, and which therefore I would more emphatically impress upon the younger members—the training which is obtained in preparing papers for a Society like this.

The choice of a topic for to-night's address has given me much thought, but after consideration I decided not to take up any subject bearing on Actuarial Science, but rather to make a few remarks on one of the Departments of practical work falling to those of us who are connected with life assurance offices.

The work of an assurance office may be divided into six principal sections, viz.:—

(1) Selection of lives.
(2) Calculation of premiums.

(3) Investment of the premiums and other receipts.
(4) Office book-keeping.
(5) Valuation of the policies at specified intervals : and
(6) Payment of claims.

The other departments of office work are in a measure dependent on some one of those I have mentioned.

I propose to take up the first section, and to give a few notes on the general rules to be observed in selecting lives for assurance. Doubtless to the older members of the Society my remarks will appear to be mere platitudes, conveying little more than what one might call the alphabet of our business, but many of the younger members who have not become practically concerned in the consideration of proposals for assurance, have not yet begun to learn 'the alphabet.'

An assurance office by charging premiums based on the mortality of the population, should be able without loss to insure the general population, provided all came forward. As a matter of fact however the whole population does not assure. If we have only a portion of the community assuring, that portion will, speaking broadly, consist of two classes; on the one hand, those who honestly believe themselves to be good lives and take out policies either as a provision against the uncertainty of life or as an investment of their savings; and on the other, those who knowing they are bad lives hope to secure a bargain by means of an assurance policy. The health of the former class will fairly represent that of the general population, and their average longevity will be somewhat similar; but the deaths among the latter will take place at earlier dates than in the general population: consequently without some safeguard against the latter class —an office would soon have on its books an undue proportion of inferior lives. This safeguard consists in the selection exercised by the offices, which, though it may not be perfect enough to prevent all bad lives from procuring policies, limits the number of such fraudulent assurances to a small proportion. In addition to performing this function, it has also the advantage of weeding out from the class of proposers who honestly think themselves eligible, many who in consequence of flaws in their constitution or of their habits of life, the effect of which is unknown to the proposers themselves, have not the same prospect of living out their expectation as ordinarily healthy persons.

The selection in favour of the office thus not only modifies the effect of selection against it, but also sets up other influences which result in assured lives in the aggregate having a greater longevity than that of the general population. This superiority is very decided in the years immediately following the opening of the policy and gradually becomes less marked, until in the later

policy years the mortality of assured lives becomes very similar to that of the general population.

The following table gives the proportion of deaths among assured males and females respectively and among males and females in the general population—the basis of the former being the experience of the twenty offices on which the 'Healthy Males' and 'Healthy Females' tables of the Institute were founded; and that of the latter the 'English Life table, No. II. (males and females).'

TABLE I.

TWENTY OFFICES' EXPERIENCE.

Actual deaths among male and female lives and corresponding expected deaths according to English Life (No. II.) table.

Age at death.	Males.			Females.		
	Actual deaths.	Expected deaths.	Ratio per cent.	Actual deaths.	Expected deaths.	Ratio per cent.
15–19	36	53·2	67·7	20	20·2	99·0
20–24	232	285·7	81·2	43	44·2	97·3
25–29	659	881·5	74·8	107	86·7	123·4
30–34	1,273	1,583·1	80·4	150	139·9	107·2
35–39	1,772	2,151·2	82·4	196	190·5	102·9
40–44	1,980	2,497·1	79·3	229	232·3	98·6
45–49	2,209	2,597·3	85·0	248	258·9	95·8
50–54	2,271	2,532·8	89·7	272	311·2	87·4
55–59	2,334	2,456·4	95·0	317	372·3	85·1
60–64	2,312	2,450·3	94·4	373	421·6	88·5
65–69	2,040	2,142·4	95·2	410	437·8	93·7
70–74	1,609	1,669·1	96·4	400	403·3	99·2
75–79	1,054	1,049·4	100·4	318	300·8	105·7
80–84	527	494·4	106·6	147	169·9	86·5
85 and upwards.	199	185·9	107·0	93	84·1	110·6
Total,	20,507	23,029·8	89·0	3,323	3,473·7	95·7

To show the benefit of selection in the early policy years and its gradual disappearance, another table is given of (1) the actual deaths among healthy male lives from the twenty offices' experience, arranged under year of assurance; (2) the corresponding number of deaths expected by the 'English Life table, No. II. (males)'; and (3) the percentage of actual to expected deaths.

TABLE II.

TWENTY OFFICES' EXPERIENCE.

Actual deaths among male lives arranged under years of assurance, and the expected deaths, according to the English Life, No. II. (males) table.

Year of Assurance.	Actual deaths.	Expected deaths.	Ratio per cent.
0	291	788·6	36·9
1	892	1,501·2	59·4
2	1,030	1,382·9	74·5
3	1,076	1,293·2	83·2
4	1,110	1,214·0	91·4
5	998	1,150·1	86·8
6	995	1,096·5	90·7
7	947	1,039·8	91·1
8	884	980·8	90·1
9	851	929·2	91·6
10–14	3,765	3,933·5	95·7
15–19	2,827	2,879·7	98·2
20–24	2,014	2,064·1	97·6
25–29	1,340	1,353·3	99·0
Total,	19,020	21,606·9	88·0

It will be seen that selection has at first reduced the deaths to one-third of the expected—thereafter varying from about two-thirds to nine-tenths of the expected, till ten years of assurance have expired; and that during the remaining period under review (twenty years more, or thirty years in all), the actual deaths increase until they closely approximate to the expected deaths.

The subsequent deterioration among assured lives is doubtless due to a considerable extent to a third form of selection, operating against the office, by those who withdraw from it.

As time goes on a proportion of the lives, which being selected are at the start presumably of sound constitution, retire either by surrendering their policies or allowing them to lapse. During the interval some of the lives will have deteriorated, but as these will make every effort in their power to keep up their policies, the probability is that there will be few, if any, bad lives among those who retire, and the proportion of bad to good among those who remain on the books will tend to increase.

The question of selection by discontinuance and its effect on the subsequent rate of mortality is, however, foreign to our subject.

What we have to keep in view is—that offices are threatened with an adverse selection, which they counteract by a selection on their own behalf.

The adverse selection is due mainly to what one may call the dishonesty of inferior lives (in many cases without consciousness of dishonesty on their part) who desire to assure on the same terms as normal lives. One proposer may be aware that he is suffering from a disease which will shorten life. Another, without actual knowledge of disease, may feel symptoms which lead him to suspect the soundness of his constitution. Probably such cases bear a small proportion to the number of proposals for assurance, but it is certain that many more would arise if it were not known that offices take means to safeguard themselves.

Before proceeding to explain the manner in which the selection by the offices is exercised, I should like to state shortly the extent and limitations of the duty which may in the future devolve upon you in the discharge of that part of office work. You are aware that in this country the function of selecting lives for an assurance office is vested in Boards of Directors. It is the duty of the executive officials of the various offices to obtain the information necessary to assist the Directors in coming to a decision, and, in consultation with the principal Medical Officer, to advise them on the subject. While the bulk of the responsibility rests with him, in his capacity as skilled adviser, it is important that the official in charge of the proposals (whatever his position may be), should make himself acquainted with the various points to be kept in view. In cases of exceptional difficulty, he will be wise to refrain from forming a definite opinion until he has consulted the skilled adviser, but in order to prepare for such consultation, he should, by careful study of the papers, have brought into focus in his own mind all the facts bearing on the eligibility of the life. As a preparation for performing this function properly, it is necessary that he should acquire a sufficient knowledge of medical life assurance science, to enable him to understand how the various circumstances of family and personal history affect prospects of longevity. It may be too much to expect from the Actuary a thorough knowledge of medical science, but while there is a certain truth in the adage that 'a little learning is a dangerous thing,' yet if our 'little learning' is tempered with a full consciousness of its small proportions, we shall find that little a wonderful help in our business.

A generation or two ago, the medical principles of life assurance science could only be learned from practical office work, but fortunately for the younger generation of the present day, there are several text-books on the subject. The amount of the available information is receiving daily additions from the proceedings

of the Medical Officers' Associations in this country and in America. The proceedings of the assurance section of the last meeting of the British Medical Association, held in this city, contain much valuable matter, a great part of which was contributed by members of this Society; nor must I omit to mention the useful papers on the subject read before various Actuarial Societies and communications to the Insurance press.

The points to be kept in view in the selection of lives for assurance may be divided into three main heads, viz. :—

(1) The habits and mode of life of the proposer.
(2) His family history.
(3) His personal history and condition.

Habits and mode of life.—With reference to the first point, viz. :—Habits and mode of life—information is required in order that we may as far as possible prevent lives deteriorated by intemperance from being placed on our books. I say—as far as possible; for full and reliable information as regards habits cannot always be obtained. With a little trouble family history can generally be thoroughly investigated; and a good medical examiner is able in all but a small proportion of cases to exclude persons either suffering from disease or whose organs have been injuriously affected by past illnesses; but there is often difficulty in getting precise information about habits. It must be kept in view that we wish to exclude not only those who are actually drunkards, but also those who, although they are never actually intoxicated, take a larger quantity of stimulants than is beneficial.

Our information as to habits is obtained from the statement of the assured himself, from reports by friends referred to by him, and from reports by the agent and the medical examiner. At first sight, one would say that with such an amount of evidence we should be able to detect all cases of intemperance; but unfortunately, without any fault on the part of the office, a proportion is accepted. The friends to whom the intemperate proposer refers may be persons of a character and mode of life similar to his own. The description 'sober and temperate' is comparative; and there is a vast difference between the idea which the words convey to a total abstainer and to a person who is in the habit of 'living freely.' If the proposer be a 'free liver,' his friends may also be, and often are, 'free livers,' so that even though his method of life, if it were made known, would cause the proposal to be rejected, very often we find in such cases that the reports received from the friends cast not the slightest doubt on the question of sobriety.

When the proposer is introduced by a reliable agent, who is acquainted with him, there is generally little cause for doubt, as

the agent's report will bring out the facts. But in a great many cases the agent is not sufficiently intimate, and in others, the knowledge that his commission will depend on the information he gives, may induce him to withhold details which he thinks of little importance, but on which a board of directors would place considerable weight.

If the medical examiner is acquainted with the proposer, his opinion as to habits may be relied on; but this applies mainly to proposals received from country districts. As a rule, medical men in large towns are not acquainted with proposers. The form of report includes a question to be answered by the proposer, 'Are you temperate?' and the medical man is asked, if, in his opinion, 'the appearance of the applicant is that of a person who is and always has been of temperate and regular habits?' In extreme cases true information can be obtained by this means, for the medical examiner can generally detect symptoms of prolonged intemperance, but as such habits take a considerable time before they produce tangible effects, the medical examiner naturally gives a favourable report if the proposer is free from such signs.

The information obtained from the proposer himself is seldom of any value. Most men think themselves temperate whatever their habits may be, and of the rest, some have little hesitation in misleading. One meets some cases of strict conscientiousness, but these are few in number. The answer to the inquiry, 'Are you temperate?' if given in the affirmative, need not carry conviction. Some offices insert queries in the medical report to ascertain the usual quantity of stimulants the proposer is in the habit of taking, but even that precaution is seldom sufficient, for as a general rule the information given will err on the side most favourable to the proposer.

The foregoing will explain how a proposal on a life ineligible on account of habits of intemperance may come to be accepted. The papers may present no difficulty, and a policy may be issued to become probably an early claim. Such cases cannot be guarded against. All that lies in our power is to look carefully into all proposals where a note of warning is sounded, and when the friend replies that a proposer is not sober, or has at one time been intemperate, full inquiries should be made. If detailed information bears out that the proposer is at the present time drinking to excess, the case should be declined.

The question sometimes arises whether a life can be accepted when there has been a solitary case of excess. The reports perhaps show that the proposer has been seen intoxicated at a wedding or some such merry-making. Then we have the farmer who gets drunk occasionally on market-days. Each case should be decided

according to the special circumstances after exhaustive inquiry. One general rule can be given—when in doubt, decline.

Care is very important when the proposer has been at one time habitually intemperate, but has reformed. In this case also it is impossible to lay down a rule, but when the irregularities have taken place in youth, and a sufficient interval has elapsed to render a recurrence less likely, the proposal may probably be accepted. In youth the organs have more power of recuperation than in later years, and are not so likely to be permanently affected; but where the intemperance, though now given up, extended to mature years, the life should be looked upon with doubt. The constitution will probably have been undermined, and at the same time bad habits are more likely to recur. I will only venture to lay down one other general rule on the subject, viz.:—That a proposal where there is a suspicion of intemperance and also intemperance in the family history, should not be accepted.

Family history.—We have now to consider the second main element in the selection of lives, viz.:—The effect of the family history of the proposer on his prospects of longevity.

The model life for an assurance office is that of the man sober and temperate in his habits, with physique in perfect condition, who has had no serious illness since childhood, whose father and mother are either living or have died of old age, and whose brothers and sisters are also living and healthy. As you know, however, such a conjunction is the exception and not the rule, and we have to decide what course is to be adopted in the numerous cases where the standard is not reached. As a matter of experience, when a decision has to be made as regards the eligibility from the point of view of the family history, there is more room for doubt than in the case of habits. In the latter, if the information is on the whole held to be satisfactory, the life is eligible; if unsatisfactory, it is ineligible. There should be no question of rating up when habits are doubtful. The various facts connected with family history, on the other hand, render possible a class between the eligible and the ineligible, and for this intermediate class the amount of extra risk with the corresponding extra premium has to be assessed according to the circumstances of the case. You will thus see that as we proceed the problem becomes more complex.

The theory which causes us to take into account the facts of family history proceeds on the assumption that man, to a certain extent, inherits the constitution of his ancestors, and many of the maladies from which they have suffered. We therefore wish to ascertain the conditions of health of the immediate ancestors of the proposer and of his brothers and sisters in order that we may obtain data for forecasting his prospects of longevity. At

one time perhaps too much stress was laid on the influence of hereditary predisposition, which we call heredity. Modern scientific opinion tends to the view that many diseases held in former days to be hereditary are not so, and that a past generation exaggerated the power of the hereditary taint. The question, however, as to the weight to be placed on family history is one of degree merely, for there is no doubt that it is an important factor in selection.

The diseases commonly met in the family history which are most to be feared on account of their hereditary tendency are consumption, insanity, cancer, and gout. The statement that all these are hereditary, however, can only be accepted with some modification. Take consumption as an example. Statistics show that in a period of thirty-four years, from 1858 to 1892, the number of persons per million inhabitants who died of consumption in England and Wales fell from 2565 to 1468 per annum. Such figures are calculated to shake our confidence in the hereditary theory; for if the actual disease were transmitted from parent to child we should have expected to find that the number of deaths would have increased with the increase of the population, or, even if allowance be made for improved conditions of life, no great reduction could be looked for in the course of one generation.

The view generally held in the present day is that consumption does not descend from parent to child, but is contagious; that a considerable proportion of the cases arise from actual infection; and that by taking steps to separate the sick from the healthy, its virulence can be still further abated. But while we may doubt the influence of consumption in transmitting the disease itself, it is unwise to ignore it when we find it entered as a cause of death of some relative of the assured. A consumptive parent may not have transmitted the disease, but he has possibly transmitted an organisation which, if placed in similar circumstances and rendered subject to similar causes, may produce the same results. I have extracted from an address by Dr. Payne to the Life Assurance Medical Officers' Association an explanation of heredity in disease which puts the matter in a few words.

'Heredity in disease may be of several kinds—

'*First.* There may be a direct inheritance from either parent of the specific cause of disease, which might be called parental infection. This mode is the rule in syphilis, and may occur in tubercule, though as regards the human subjects very rarely.

'*Second.* There may be an inheritance of some structural abnormality.

'*Third.* There may be a transmission, not of actual disease, but of some peculiarity of the tissues—call it weakness or vulner-

ability—which makes the individual less able to resist either injuries in general or some special kind of injurious agent.

'The facts of heredity in disease may be explained on any of these hypotheses. If the last, which seems to be the most widely influential, be adopted for any particular disease, then the proof that this disease is caused by any parasite or microbe entering from without would not destroy the evidence of hereditary predisposition.'

It is probably the last—transmission, not of actual disease, but of some peculiarity of the tissues—which comes most prominently before us in connection with life assurance. You can therefore understand from what has been said that it is important we should have full and correct information as regards the family history of the proposer, *i.e.* as to age and present health of his father, mother, brothers, and sisters, if alive, and the age at death and causes of death of those who are dead. In some cases offices go further, and ask for similar information as regards grand-parents and their children. One American writer recommends strongly that the observation of three generations should be obtained, and I recollect reading the opinion of another who states that a fair estimate of the assured's lifetime could be obtained by taking the ages of the two parents and four grand-parents and dividing the result by six! Unfortunately it seldom happens that we are able readily to get reliable information as to the history of the grand-parents, and it may, I think, be dispensed with, except where several cases of the same form of disease appear in the family, or where the family history gives us no guidance in consequence of the father and mother having died before middle life, from diseases to which we would otherwise attach little importance.

The particulars of the family history are generally furnished in the medical examiner's report. It will be your duty to see that it is properly filled up, and to obtain any additional information that may be required. Many medical men are satisfied to enter the causes of death in the family in misleading or meaningless terms. The model form of medical report adopted by the Life Assurance Medical Officers' Associations contains the following instructions:—

> 'The Medical Examiner is particularly requested to obtain precise information as to the cause of each death. Such terms as Childbirth, Dropsy, Natural Causes, Change of Life, etc. should be avoided.'

You can quite understand the reason for objecting to these terms. 'Childbirth' may mean many diseases—from puerperal fever to consumption after childbirth; dropsy is merely a symptom of disease, and may proceed from heart disease, kidney

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disease, or liver disease; while 'natural causes' gives no information whatever except that the person did not die a violent death.

With information fully before you, you have then to study if the life is a normal one, or has acquired a tendency to premature or early death, and in the latter case to judge if he should be rated up or declined.

I propose to devote one or two paragraphs to a few of the diseases which, when they appear in the family history, should influence your opinion, doing so, however, merely as an indication of the process to be employed. The subject is too large to be treated to-night, even superficially, in all its branches.

Phthisis.—The class of disease in the family history against which selection exercises the most potent influence is that comprising phthisis, consumption, or other tubercular disease, contributing as it does nearly thirty per cent. of the deaths in the general population. Though one cannot say how much benefit assurance offices have gained by selection, in avoiding lives with a tendency to these diseases, there is no doubt it has been very considerable. Mr. Dovey, in a paper in the *Journal of the Institute of Actuaries* (vol. xxiii.) gives a table (copy of which follows) comparing the general mortality and assured mortality from consumption both in this country and America, showing that the ten Scottish offices combined experienced a mortality from consumption of about one-half of that among the population of Scotland; while in the New York Mutual, although the rate of mortality from consumption was greater than that of the Scottish offices, it amounted to less than one-fourth of that in the population of New York.

TABLE III.

Annual number of deaths from consumption to 10,000 men living at each group of ages.

Ages.	British Lives.			American Lives.		
	10 assurance companies.	Population of Scotland.	Rates per cent. of assured to general mortality.	New York Mutual.	Population of New York.	Rates per cent. of assured to general mortality.
20–29	23	46	50	24	70	34
30–39	21	35	60	20	71	28
40–49	16	31	52	17	66	26
50–59	13	30	43	14	84	17
60–69	8	27	30	18	110	16
70–79	6	17	35	30	151	20
Total,	87	186	47	123	552	22

The foregoing figures must, however, be taken with some reservation. As I have already explained, the child does not so much inherit disease as a tendency to disease; and it does not necessarily follow that, because the deaths from consumption are less numerous, the mortality must be more favourable in the same proportion; but even making allowance for this consideration, there remains no doubt of the superiority of assured lives.

When one or two deaths from consumption occur in the family history of the proposer, other details may come to be of value. The age of the proposer has to be considered. It is estimated that at age 40 half, and at age 50 three-fourths of the danger is past. The personal physique of the proposer is still more important. If the circumstances in which he is brought up have tended to counteract the hereditary liability, we are justified in placing less weight on the hereditary taint. In corroboration of this theory I may point to the results of an investigation made in 1895 by Dr. E. J. Marsh, the medical director of the New York Mutual. He compared a number of deaths among policyholders in that office whose family history showed no consumption, with an approximately similar number with a record of consumption; and again sub-divided both into groups according to the individual weight, viz.: (1) those whose weight at the age of assurance was equal to or above, and (2) those below the company's standard average of weight; in order that he might ascertain if general robustness had modified to any extent the tendency to consumption. Weight is taken as the test of robustness, I presume, because it is the only one available. The following are the ratios per cent. of deaths by consumption to deaths by all causes among the four classes.

TABLE IV.

Mutual of New York. Percentage of deaths from consumption among selected number of deaths from all causes (Dr. E. J. Marsh).

Age.	At or above average weight.		Below average weight.	
	No taint.	With taint.	No taint.	With taint.
To–29	17·8	25·	41·1	48·9
30–39	8·5	11·3	19·1	28·2
40–49	4·6	6·7	10·7	14·1
50 and above	2·7	3·5	9·3	7·3

As in the last table, and on the same grounds, the figures have to be taken with a certain amount of limitation, but they sufficiently prove that lives with poor physique, whose family history is favourable, are more likely to die of consumption than lives with a hereditary tendency, and a good physique.

Before departing from the question of the standard of weight, I may give the following rule formulated by Dr. Brinton :—'An adult male in good health, 66 inches in height and under 40, ought to weigh about 140 pounds; and for every inch above and below this height, we may respectively add and subtract about five pounds.' This fairly tallies with the Table of weight (including clothes), calculated by Dr. Hutchison :—

Height	5 ft. 1	120 lbs.
„	5 „ 6	145 „
„	6 „ 0	179 „

Dr. Marsh's investigation in other respects shows some curious results :—that the group of persons with a family history of consumptive taint (1) in a parent; and (2) in a brother or sister, give aggregate numbers of deaths from that disease which are nearly equal : that the number of deaths is greater than in either of these classes, when (3) the parent and brother, or (4) parent and sister died of consumption; and that the class subject to the heaviest mortality from that disease consists of a fifth group, in which two or more brothers or sisters have died of consumption. Results such as these indicate that it is not wise to form an opinion, by placing the lives in classes according to the number of deaths in the family from consumption, and that we ought to weigh all the other surroundings. For instance a life aged 40 with good physique, even with two cases of consumption in his family history, should probably be looked upon more favourably than a man of 30 under average weight, with only one.

Cancer.—Cancer, the next so-called hereditary disease we shall consider, differs from consumption in so far that the hereditary effect which we fear is an actual appearance of the disease itself: whereas in the former, the danger arises from an inherited weakness which may result in maladies of a different nature.

The mortality from cancer among the population has increased to a large extent during late years. In the years 1881 and 1895, the numbers of deaths from cancer out of each million males living, were respectively 364 and 586. The great increase during the fourteen years, may partly arise from greater accuracy of diagnosis, but probably the main cause lies in the theory advanced by some medical men, that the decreased mortality from phthisis and acute inflammatory diseases which generally prove fatal in early or middle life, has resulted in a larger number of weak organisations surviving, many of whom fall a prey to cancer—essentially a disease of later life. No adequate statistics bearing on the hereditary effects of cancer are available, and we are therefore in the dark as to the weight to be given to it when it appears in family history.

The consideration I have just mentioned may, however, be kept in view, when assessing cancerous risks. As it appears at a

more advanced age, the office need not fear the serious loss which may result from consumptive cases. The following set of rules are given by Dr. Payne in a paper on the subject, read before the Life Assurance Medical Officers' Association :—

'Male Lives.—One death from cancer may be neglected, but two such require an addition. A case calling for rejection on this ground would hardly occur.'

'Female Lives.—In a whole-of-life policy, the death of even one relative from cancer must be taken into account. The death of the mother requires a special addition. If one other female relative has died from the same disease, the risk is serious and in some cases even prohibitive.'

Insanity.—The method in which a case should be treated, when insanity occurs in the family history, is a matter of some difficulty. On the one hand the disease is undoubtedly hereditary, but, on the other, its effect on the duration of life is not so marked as in the majority of other diseases. It may be sufficient if without going further into the question, I quote the opinion of Dr. Pollock and Mr. Chisholm from the *Medical Hand-book of Life Assurance* :—

'That the issue of one insane person might be accepted if 35 to 40 and without any nervous affliction.

'If his brothers and sisters have been affected, the case is more doubtful, but perhaps a suitable addition to the premium might compensate the risk.'

Personal history.—The third of the main headings on which selection is based, viz.: the personal history—that is, the history of the past ailments and present condition of the proposer—is undoubtedly the most important of the three; but I have already taken up so much of your time, that I cannot go into it as fully either as I should like, or as the matter deserves.

The medical examination by which we are informed as to the past personal history of the assured and his present physical condition, is the most powerful part of the machinery of selection, In the first place, it enables us to eliminate all lives except those which are in thoroughly good condition, with the reasonable prospect that for the first year or two the number of early deaths will be comparatively small in number. Its effect on the mortality rate continues for a long period (although not to so great an extent as at first), by reducing the number of deaths from those classes of disease where medical examination can observe premonitory symptoms, or detect weakness in the organs which are liable to such diseases.

An idea as to the effect of selection following medical examination may be gathered from the figures in the following table, based upon the deaths in the twenty offices' experience, which I extract from the paper by Mr. Dovey, to which I have already referred.

TABLE V.

Ratio of actual deaths among assured lives, by the undernoted diseases, to 100 deaths expected according to the experience of population for years 1855-64, as detailed in the eleventh report of the Registrar-General for Scotland (W. R. Dovey, *J.I.A.* Vol. XXIII.).

Years of assurance.	Turbercular diseases, including consumption.	Diseases of heart and blood-vessels.	Lung diseases, excluding consumption.	Diseases of urinary organs.	Zymotic diseases.	Diseases of brain and nervous system.	Diseases of digestive organs.	Diseases of uncertain seat.	Total diseases.
0	9·97	21·59	31·08	27·41	99·63	41·28	70·19	16·67	35·85
1	26·72	44·49	48·96	46·04	103·00	71·14	83·47	53·16	57·90
2	52·21	62·63	62·99	45·18	117·38	94·99	98·75	79·91	72·19
3	58·27	68·16	51·98	75·13	105·42	110·17	123·38	84·86	80·94
4	56·91	82·72	73·21	95·62	109·61	126·52	103·02	101·80	89·17
5	55·94	58·02	55.21	121·56	126·15	127·75	106·85	114·27	85·54
6	67·79	89·83	76·12	89·46	113·75	135·74	109·38	96·90	89·49
7	63·20	76·38	59·95	64·85	125·85	127·92	118·95	102·00	89·65
8	58·28	93·24	59·84	92·00	103·99	148·09	113·90	60·64	88·68
9	60·93	79·03	73·12	101·62	105·67	141·93	105·24	101·85	90·49

I would direct your special attention to the above table as it shows very distinctly the lines on which medical selection comes to the aid of assurance offices. Medical examination enables us to find out if the heart, lungs, or kidneys have already begun to show signs of disease or contain abnormalities which would render them susceptible. It cannot prevent a malady supervening in the future, but it can detect cases where these organs are likely to be affected. The result is seen in the first four columns where, taking the first line, deaths from disease of the heart, lungs, and kidneys vary from about one-tenth to one-third of the expected rate. These small ratios, as might be expected, are not kept up in future years, but in all the policy years included in the table a marked improvement over the expected mortality is shown. On the other hand, medical examination cannot so thoroughly detect latent mischief in the brain or digestive organs. It can only enable us partially to eliminate cases where these organs are unhealthy at the time of assurance. A proposer with diseased heart or kidneys is not likely to be successful in deceiving the medical examiner, but one with an internal tumour, or whose nervous system is seriously out of order, might hope to pass the ordeal. This is seen in the table where in the first two lines mortality from diseases of the brain or digestive organs is light as compared with the expected mortality, but is much heavier than in the previous four classes. In the third policy year the actual deaths approximate to the expected and thereafter exceed them. The heavy mortality in the latter half of the table is partly accounted for by the fact that a large proportion of assured lives is drawn from the professional and mercantile classes, which are susceptible to ailments of the brain and digestive organs—especially the former.

Your principal duty in considering that portion of the medical report which gives information as to the *present* physical condition will consist in judging if and to what extent the life varies from the normal standard; but in most cases of abnormality it would be well that you should suspend your judgment until you have obtained the opinion of the principal medical officer. The method of treating the *past* personal history, however, opens up a wide field suitable for your study. It contains such problems as—the course to be pursued if the life is unvaccinated; what extra is to be imposed for gout; under what circumstances a life may be accepted who has suffered from rheumatism, or syphilis, or blood-spitting, or appendicitis, or discharge from the ear, or epilepsy; what extra premiums are to be imposed for hazardous and unhealthy occupations, or for foreign residence; and the still larger question as to the terms on which female lives should be accepted.

As examples of a method of dealing with such problems I select two, viz. those applicable to proposers who have suffered from gout and syphilis, giving in the former case the opinion of Dr. Marsh of the Mutual of New York, and in the latter that of Dr. P. H. Maclaren of Edinburgh.

Gout.—'In every case, the presumption is against the acceptance of an applicant who has had gout, and the case must be proved to be suitable for an exception, after more than ordinary scrutiny and investigation. The cases which might form such exceptions cannot be defined, and each must be individually decided by the responsible Medical Adviser of the Company, but I think they should be limited to the following:—

'1. There should be an entire absence of hereditary tendency.

'2. The first attack of gout shall not have appeared before 30 years of age.

'3. The attacks shall have been very few in number and slight in character, and several years shall have elapsed since the last attack.

'4. That the person shall not have had gravel, frequent uric acid deposits in the urine, or symptoms of lithaemia.

'5. The habits must be abstemious, both in eating and drinking, and the applicant must have given evidence that he appreciates the necessity for this course of life.'

Syphilis.—'If a man has been properly treated, provided he is of good constitution and habits, the probabilities are that no complications will arise, and the expectation would be that he would go through life with scarcely any more appreciable risk than one who never has had the disease. If the applicant has not undergone a sufficient course of treatment, and applies for insurance before the expiration of six years, the period at which the disease normally terminates, and yet is not suffering from any tertiary manifestations, and is otherwise satisfactory, the chances are that he may escape the malign form, but 10 per cent. extra should be charged until the expiration of six years, and the case then reconsidered. When tertiary symptoms have developed the case should be absolutely declined. There is a tendency to recur, and such victims rarely live beyond a term of ten years, and often much less when palliative treatment is not carried out.'

I have hitherto confined myself to the case where there is a flaw in only one of the two elements of family and personal history, but you will meet cases where there are flaws in both, and such a condition renders the matter still more complicated. There is a good deal of common sense in the rule that when the life shows a combination of inferior family and personal history it

should be rejected, unless the flaws are so unimportant as singly to require no addition to the premium; but like other rules it has its exceptions, and you have to treat each case on its own merits.

There are other points, such as the surroundings of the life, the object of the assurance, the amount of it as compared with the position of the proposer, etc., which should be taken into account when forming your judgment;—but time prevents me from enlarging on them. I have been able to investigate only a few of the considerations which should influence you. I think, however, enough has been said to show that a proper study of the subject, in addition to furnishing knowledge useful to you in your business, is calculated to provide an excellent training for the mind. The principles cannot be learned by rule or by memory, and in order to master them you will require the exercise of sound judgment and a fine balancing of conflicting elements. It would not be amiss if the subject were generally recognised as part of the study of an actuary, for it is undoubtedly one of those he most requires to fit him for the duties he is called upon to perform. The profession of an actuary is a many-sided one, and to be thoroughly equipped a very varied knowledge is necessary. We all acknowledge that a thorough acquaintance with mathematics is his first requisite, and, in view of the enormous monetary responsibility cast upon him, that his training cannot be complete without a knowledge of finance, comprising as it does a study of political economy of our own and foreign governments, of the course of trade, and of the influences which affect commerce and the great industries of the world. Lastly, as I have tried to show you, you must add to these an intimate acquaintance with the human body and of the elements that make for the health and happiness of man.

On the Mortality in certain Hazardous or Unhealthy Occupations, as shown by the Official Statistics

BY

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SECRETARY OF THE SCOTTISH EQUITABLE LIFE ASSURANCE SOCIETY

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(*Read before the Actuarial Society, 8th December* 1898.)

THE Supplement to the fifty-fifth annual report of the Registrar-General for England, issued early in 1898, contains a mass of statistical material bearing on the mortality among persons engaged in various occupations, much more important and complete than any previously available. The principal object of the following Paper, is to examine the information therein contained bearing on the mortality in certain hazardous or unhealthy occupations, with a view to obtaining some guidance in fixing the extra premiums which should be charged for insurances on the lives of persons engaged in these occupations. In some cases, the information obtained from the Supplement to the fifty-fifth report has been supplemented from other official sources.

For the purpose of comparing the mortality of persons in different occupations, Dr. Tatham, the Superintendent of Statistics at the General Register Office, has, following his predecessor, Dr. Ogle, made use of the method of 'comparative mortality figures.' Dr. Tatham finds that, on the average of the three years 1890, 1891, and 1892, 1000 deaths occurred annually among 61,215 men between 25 and 65 years of age. Of these there were

22,586	in the age group	25—35	years
17,418	„ „	35—45	„
12,885	„ „	45—55	„
8,326	„ „	55—65	„

By applying to these four numbers the corresponding rates of mortality for any occupation, the number of deaths is ascertained which would occur among 61,215 men engaged in that occupation, but with the same age constitution as that of the general population. The number thus obtained is the comparative mortality figure for

that occupation, on the basis of the statistics for 1890-92. Thus the comparative mortality figure of fishermen is 845, and indicates with approximate accuracy the mortality prevailing in that occupation, as compared with the general male mortality, which is represented by 1000.

It will be seen that these comparative mortality figures are based entirely on the statistics of lives between the ages of 25 and 65. In regard to this point, Dr. Tatham states as follows:—
'Dr. Farr in his Supplement to the thirty-fifth report, indicated 'the period of life between 25 and 65 years of age, as that in 'which "the influence of profession is most felt." Ten years 'later, Dr. Ogle adopted the same view, supporting it by the 'argument that "in the earlier age-periods the effect of occupation 'is not as yet fully developed; and the last age-period, 65 years 'of age and upwards, is that which is more especially affected by 'the retirement from the industry, of such men as have become 'too weakly to follow it." My own recent inquiries having tended 'to confirm the opinions expressed on this subject by my prede-'cessors, I have, in the present volume, retained the same interval, 'namely, that between 25 and 65 years of age, as marking the 'period of life during which the effects of occupation are most 'conspicuous.'

Following the course adopted by Dr. Tatham, I have, in this Paper, dealt only with the statistics of lives between 25 and 65 years of age. In explanation of Dr. Ogle's reason for excluding the statistics of lives above age 65, I may state that in the classification according to occupations made at the last census, persons retired from business were, with a few exceptions, not classed under their former occupations, but under a special heading, 'retired from business'; and the same principle has of course been followed in preparing the tables of deaths in various occupations contained in the Supplement to the fifty-fifth report. The advantage of classing under each occupation, both those who are actively engaged in it and those who have retired from it, (as was done previous to the census of 1881) is, that we thereby retain under observation the numerous cases of men who, without actually dying in harness, break down in health, and have to retire from active work. To exclude the retired, is in fact to exclude a body of men, which is certain to contain a large proportion of men in broken-down health; and has the effect of underrating the mortality in the class under examination. The retired are, of course, much more numerous at ages above 65; and their exclusion has, at these ages, a greater disturbing effect on the rate of mortality.

Dr. Tatham has, as stated above, calculated his comparative mortality figures with reference to the mortality among all males

as a standard: but in examining the mortality of a particular occupation, he generally compares it with the mortality among occupied males. The class of all males includes lunatics, prisoners, paupers, and persons physically unfit for employment, and I have followed Dr. Tatham in taking as my principal standard of comparison the mortality among occupied males.

A serious difficulty which occurs in comparing the death-rates of different occupations, is referred to in the following extract from Dr. Ogle's letter in the Supplement to the forty-fifth report of the Registrar-General. He says:—'There are 'many trades and occupations which require a considerable 'standard of muscular strength and vigour to be maintained 'by those who follow them, such occupations for instance as 'those of a blacksmith, of a miner and the like; and so soon 'as, from any cause, the health and strength of a man fall below 'this standard, he must of necessity give up the occupation, and 'either take to some lighter kind of labour or, if his health be 'too much impaired for this, retire altogether from work. . . . 'The weaker individuals and those whose health is failing them, 'are thus being constantly drafted out of each industrial occupation, 'and especially out of those which require much vigour, and the 'consequence is that the death-rates in these latter occupations 'are unfairly lowered as compared with the death-rates in 'occupations of an easier character.' Again Dr. Ogle says:— 'Another very serious flaw in these death-rates, when taken as 'measures of the relative healthiness of different industries, is due 'to the fact that these several industries do not start on equal 'terms as regards the vitality of those who follow them. A 'weakling will hardly adopt the trade of a blacksmith, a miner, 'or a railway navvy, but will preferentially take to some lighter 'occupation such as that of a tailor, or weaver, or a shopman. 'This defect in the death-rates as measures of comparative 'healthiness of occupations, tells in the same direction as the 'defect previously noticed: it gives an unfair advantage to such 'industries as demand much strength or activity in those who 'follow them. Such industries are in fact carried on by a body 'of comparatively picked men, stronger at the beginning, and 'maintained at a high level by the continual drafting out of those 'whose strength falls below the mark.'

In order to obtain, if possible, some light on this point, I have made a classification of all the occupations given in Dr. Tatham's Table I., according to the nature of the occupation. Mr. A. G. Finlaison, late actuary of the national debt, in his report on the sickness and mortality in Friendly Societies, 1853, divided the occupations dealt with by him, with certain exceptions, into four classes, according to the nature of the labour required, and the

conditions under which it is carried on; namely, as involving (1) light labour without exposure to the weather; (2) light labour with exposure to the weather; (3) heavy labour without exposure to the weather; or (4) heavy labour with exposure to the weather. Distributing the occupations in this way (see Appendix A), we may be expected to obtain the means of comparing the rate of mortality in any occupation requiring a high standard of health and strength in those who follow it, with the rate prevailing in the whole class of occupations pursued under the same conditions, and thus to some extent of eliminating the source of error pointed out by Dr. Ogle in the passage given above.

In addition to the comparisons mentioned above, I have shown, in the case of each occupation, how the mortality compares with that of the Institute H^M Table.

The following Table 1 shows the death-rates among occupied males referred to above, alongside of the corresponding rates according to the Institute H^M Table. These rates are the central death-rates for each group of ages; and the word death-rate is used throughout this paper, as meaning the central death-rate.

TABLE 1.—*Death-rates,* 1890-91-92, *compared with the rates according to the Institute H^M Table.*

Ages.	Occupied Males.	Males occupied in light labour.		Males occupied in heavy labour.		Institute H^M Table.
		Without exposure to weather.	With exposure to weather.	Without exposure to weather.	With exposure to weather.	
25–35	7·29	7·29	6·46	6·98	7·33	7·55
35–45	12·43	12·32	11·30	12·12	12·31	10·17
45–55	20·66	20·65	17·36	22·71	19·21	15·72
55–65	36·66	37·41	31·65	44·95	32·81	29·41

The Supplement to the fifty-fifth annual report of the Registrar-General was preceded by three similar supplements. In the supplements to the twenty-fifth and thirty-fifth reports, are given tables of the deaths at various ages, of males engaged in different occupations in the years 1860-61, and 1871 respectively; while a table of the deaths in 1851 is given in the fourteenth annual report of the Registrar-General. These tables, taken together with the Occupation Tables given in the volumes containing the results of the English censuses of 1851, 1861, and 1871, afford the means of ascertaining the mortality of persons following various occupations in these years, and comparing it with any standard that may be desired. The Supplement to the forty-fifth

report contains tables of the deaths, at various ages, of males engaged in different occupations, in the years 1880-81-82; the corresponding years of life, taken as equal to the number of males enumerated at the census of 1881 multiplied by 3, and the mortality per 1000. In the case of certain occupations, I have, making use of these materials, calculated the actual rate of mortality between the ages of 25 and 65, in the years mentioned above, and shown how it compares with the expected rate according to the Institute H^M Table.

A very important and valuable feature in the tables of deaths in different occupations now given by the Registrar-General, is that all the deaths are classified, not as formerly according to age only, but also according to cause; and in the case of each occupation, comparative mortality figures are given for the various causes of death, showing the number of deaths that would occur from each cause among 61,215 men in that occupation, but with the same age constitution as the general male population. For instance, in the case of fishermen the comparative mortality figure for phthisis is 114. The comparative mortality figure for all causes being 845, we learn that out of every 845 deaths among fishermen 114 are from phthisis. Again, the comparative mortality figure for phthisis in the case of all males is 192, so that the mortality of fishermen from phthisis is to that of the general male population, in the proportion of 114 to 192.

In the case of each occupation, I have shown how the death-rates from the various causes compare with the corresponding rates among occupied males.

The information contained in Mr. Whittall's interesting paper 'On the rates of Fatal Accident in various Occupations' has enabled me to give, in the case of certain occupations, the death-rate from accident, calculated from the deaths of 1870-71-72 and the population as enumerated in 1871.

The principal causes which render occupations in this country hazardous or unhealthy are the following, namely—(1) exceptional risk of accident; (2) the inhalation of dust-laden air; (3) exposure to the risk of lead-poisoning; and (4) the temptation to alcoholic excess. In selecting the occupations to be dealt with, I have confined myself as much as possible to clearly defined occupations, where the number of persons engaged is sufficient to give confidence in the results obtained.

Class I.—Occupations involving exceptional risk of accident.

The following Table 2 contains the names of the occupations with which I propose to deal under this head. Opposite each is given the general comparative mortality figure and the corresponding figures for some of the principal causes of death, as obtained by Dr. Tatham from the mortality of the years 1890-92. It will be seen that the occupations vary very much as regards healthiness; fishermen, railway employees, and the general body of miners show a light mortality, whereas merchant seamen, slaters, and manufacturing chemists show a heavy mortality.

In every case, of course, the comparative mortality figure under the head of accident is in excess of that for occupied males, being highest in the case of coal miners in Monmouthshire and South Wales.

TABLE 2.—*Occupations involving exceptional risk of Accident. Comparative Mortality Figures*, 1890-91-92.

Occupation.	All causes.	Phthisis.	Diseases of nervous system.	Diseases of circulatory system.	Diseases of respiratory system.	Accident.
Occupied Males . . .	**953**	**185**	**82**	**126**	**221**	**56**
Seaman, etc., Merchant Service	1352	228	117	197	225	202
Fisherman	845	114	86	128	123	148
Railway Engine Driver, Stoker, etc.	810	76	114	139	156	79
Railway Guard, Porter, Pointsman	825	147	66	100	156	137
Coal Miner	925	97	67	120	269	141
Do. (Monmouthshire and South Wales) .	1145	107	68	132	345	243
Ironstone Miner	774	90	62	84	204	86
Slater, Tiler	1322	255	80	179	315	133
Manufacturing Chemist . .	1392	162	98	168	502	98

The following Table 3 is modelled on tables given by Dr. Tatham, and shows for the same occupations, the mortality from all causes and from 15 specified causes, as compared with that among all occupied males, the mortality of the latter being taken as 100 in each case.

TABLE 3.—*Occupations involving exceptional risk of Accident. Mortality from the various causes,* 1890-91-92, *compared with that among Occupied Males.*

Cause of death.	Occupied Males.	Seaman.	Fisherman.	Railway Engine Driver, etc.	Railway Guard, etc.	Coal Miner (Eng. & Wales).	Coal Miner (Mon. & So. Wales).	Ironstone Miner.	Slater, tiler.	Manufacturing Chemist.
All causes	100	142	89	85	87	97	120	81	139	146
Influenza	100	70	67	124	97	100	152	161	97	170
Alcoholism	100	162	23	15	38	31	54	31	123	54
Rheumatic Fever	100	57	7	100	86	100	143	71	171	100
Gout	100	00	0	50	100	0	0	0	250	0
Cancer	100	36	105	05	98	82	59	89	143	23
Phthisis	00	23	62	41	79	52	58	49	138	88
Diabetes	00	29	57	200	7	57	29	57	129	100
Diseases of nervous system	00	143	105	139	80	82	83	76	98	120
Diseases of circulatory system	00	56	02	10	79	95	105	67	142	133
Diseases of respiratory system	00	102	56	71	71	22	156	92	43	227
Diseases of the Liver	100	144	89	74	67	63	59	74	96	85
Other diseases of digestive system	100	118	8	111	64	93	107	68	68	61
Diseases of urinary system	100	139	68	83	80	73	100	76	200	27
Accident (including Plumbism)	100	354	260	139	240	247	428	151	233	174
Suicide	100	100	86	21	57	64	36	93	107	93
All other causes	100	183	105	71	74	98	94	91	123	150

The following Table 4 shows the death-rate from accident in these occupations at different ages, compared with that among occupied males. I have, in the case of this table, given the death-rate in the age-period '65 and upwards,' as, in the case of deaths from accident, the error introduced by excluding the 'retired' does not exist. It will be observed that there is in most cases a marked increase in the mortality from accident at the higher ages.

TABLE 4.—*Occupations involving exceptional risk of Accident. Mortality from accident compared with mortality among Occupied Males.*

Occupation.	Death-rate per 1000. Ages. 25 to 35.	35 to 45.	45 to 55.	55 to 65.	65 and upwards.	Number of deaths corresponding to each 100 among occupied males. Ages. 25 to 35.	35 to 45.	45 to 55.	55 to 65.	65 and upwards.
Seaman, etc., Merchant Service	2·70	3·59	3·84	3·46	3·94	410	427	349	244	185
Fisherman	2·60	2·00	2·53	2·50	2·71	395	238	230	177	127
Railway Engine Driver, Stoker, etc.	1·15	1·01	1·31	2·20	0	174	120	120	155	0
Railway Guard, Porter, Pointsman	1·90	1·78	2·33	3·91	5·30	289	211	212	276	248
Coal Miner	1·83	2·11	2·91	3·07	4·13	278	250	265	217	194
Do. (Monmouthshire and South Wales)	3·33	3·81	4·55	5·13	5·84	506	453	414	363	274
Ironstone Miner	1·16	1·31	1·67	1·89	2·05	176	156	152	134	96
Slater, Tiler	1·22	1·78	2·59	4·97	2·56	186	211	236	351	120
Manufacturing Chemist	1·02	1·98	2·12	1·63	2·56	154	235	193	115	120

I shall now deal with the above-mentioned occupations separately, giving in each case a table showing the death-rates in the years 1890-92 at successive ages, and the excess or defect of these rates when compared with certain standards.

SEAMAN, ETC., MERCHANT SERVICE.

The figures given in Table 5 relate to seamen in England or English waters.

TABLE 5.—*Mortality*, 1890-91-92, *in occupation of Seaman, etc., Merchant Service.*

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among: All Occupied Males.	Males occupied in heavy labour with exposure.	Assured Lives Institute H^M.
25–35	89,022	1159	13·02	5·73	5·69	5·47
35–45	68,172	1287	18·88	6·45	6·57	8·71
45–55	48,240	1334	27·65	6·99	8·44	11·93
55–65	21,699	971	44·75	8·09	11·94	15·34

It will be seen that, judging from this table, seamen are subject to a considerable extra mortality at all ages, the excess of their death-rate over that of the general body of males occupied in heavy labour with exposure to the weather, rising from 5·69 per 1000 at ages 25-35, to 11·94 at ages 55-65.

Table 3 shows that the mortality of seamen from phthisis is 23 per cent. above that of occupied males. In the case of diseases of the nervous system, the excess is 43 per cent.; in diseases of the circulatory system it is 56 per cent., and in the case of accidental deaths it is 254 per cent.

The annual report of the Registrar-General contains tables giving information as to the mortality in the merchant service generally for a long series of years. The figures in the following Table 6 are taken from the table in the fifty-eighth report.

TABLE 6.—*Mortality of Seamen employed in Merchant Vessels registered in the United Kingdom*, 1886-1895.

Year.	Employed.	Deaths reported.	Death-rate per 1000.
1886	204,470	3546	17·3
1887	220,266	3384	15·4
1888	223,673	3114	13·9
1889	230,263	3018	13·1
1890	236,108	3305	14·0
1891	240,480	3263	13·6
1892	241,735	3452	14·3
1893	240,974	3172	13·1
1894	240,458	3266	13·5
1895	240,486	3579	14·8
Total . .	2,318,913	33,099	14·2

These figures include masters, except in 1886.

This table shows that the average number of persons employed in merchant vessels registered in the United Kingdom, during the 10 years ending 1895, was 231,891; and that the total number of deaths reported during that time to the Registrar-General of Shipping and Seamen, was 33,099, giving an average death-rate of 14·2 per 1000. In the blue-book containing the results of the census of 1891 (Vol. IV.), there is given a table showing the ages of seamen employed in British merchant vessels at the date of the census. From the information in this age table, the following is made up.

TABLE 7.—*Number of men at each age employed in British merchant vessels in April* 1891, *with the corresponding expected deaths in a year according to the Institute* H^M *Table.*

Ages.	Number enumerated.	Expected Deaths.
Under 25 . .	54,042	313
25–35 . .	59,385	448
35–45 . .	34,800	354
45–55 . .	18,020	283
55–65 . .	4,668	137
65 & upwards	732	46
All ages . .	171,647*	1581

* Not including 27,144 as to whom sufficient information was not obtained.

This gives an expected death-rate for the merchant service, of 9·2 per 1000. Taking this as applicable to the ten years ending 1895, we obtain an excess of the actual over the expected mortality of 5·0 per 1000. This is considerably lower than the rate indicated by Table 5. The principal cause of this difference appears to be that the general body of seamen employed in British merchant vessels, contains a much larger proportion of young lives subject to a comparatively small extra mortality, than those upon whose experience Table 5 is based. Again, the deaths reported do not include deaths occurring in the United Kingdom after the seamen have been discharged from their ships.

The number employed, as given in Table 6, corresponds (except for one year) with the number of persons employed in 'sailing and steam vessels employed some time during the year,' as given in the Navigation Returns issued by the Board of Trade. In the case of 1887, the figure in Table 6 is greater by 17,723. This is exactly equal to the number of vessels employed some time during that year, and is of course also equal to the number of masters. It seems clear, therefore, that the figure for 1887 in the Registrar-General's table, is obtained from that in the Navigation Returns, by adding thereto the number of masters for that year. The wrecks as given in Table 6 appear to correspond with those given in the Wreck Abstracts issued each year by the Board of Trade; but it is impossible to compare them satisfactorily, as, while the figures in the Registrar-General's table are given for calendar years, those in the Wreck Abstracts are given for the statistical

year from 1st July to 30th June. I have, however, been able, by making use of the information in the Navigation Returns and Wreck Abstracts, to separate the figures relating to the different classes of vessels, and to show the mortality from accident and from disease respectively in each class. This is done in the following Table 8.

TABLE 8.—*Mortality among persons employed in merchant vessels registered in the United Kingdom, in the* 10 *years* 1886-1895.

Class of Vessel.		Average number employed.	Deaths reported. At sea. From Wrecks and Casualties.	At sea. From other accidents.	In rivers and harbours. From Wrecks, Casualties, and other accidents.	Total from Wrecks, Casualties, and other accidents.	Total from Disease, etc.	Total from all causes.	Death-rate per 1000 from Wrecks, Casualties, and other accidents.
Trading	Sailing	65,876	6,252	2,513	1,248	10,013	4,138	14,151	15·2
	Steam	145,014	4,408	1,711	2,423	8,542	7,034	15,576	5·9
	Total	210,890	10,660	4,224	3,671	18,555	11,172	29,727	8·8
Fishing	Sailing	17,010	1,675	1,020	105	2,800	165	2,965	16·5
	Steam	3,990	230	55	22	307	23	330	7·7
	Total	21,000	1,905	1,075	127	3,107	188	3,295	14·8
Total—Trading and Fishing		231,890	12,565	5,299	3,798	21,662	11,360	33,022	9·3

It will be observed that there is a slight discrepancy between the total number of deaths in Table 8, 33,022, and that in Table 6, 33,099. This arises from the fact that, as stated above, the deaths in the Registrar-General's table are given for calendar years, and those in the Wreck Abstracts, for statistical years. I have therefore had to assume that, of the deaths in the statistical year 1885-86, one half happened in 1885 and the other half in 1886, and to make a similar assumption as regards the year 1895-96.

Table 8 shows that the death-rate from wrecks, casualties and accidents of all kinds in trading vessels, is 8·8 per 1000; but that there is a great difference between the rates for sailing and steam vessels; the rate for sailing-vessels being 15·2 per 1000, and that for steam-vessels 5·9 per 1000.

The following Tables 9 and 10, made up by bringing together

the figures in the tonnage tables in the Navigation Returns and Wreck Abstracts respectively, show the mortality among seamen from wrecks and casualties occurring at sea, for different sizes of vessels.

TABLE 9.—*Mortality of persons employed in sailing-vessels registered in the United Kingdom, from wrecks, casualties, etc., at sea, in the* 10 *years* 1886-1895.

Tonnage.	Average No. employed.	Deaths reported.	Death-rate per 1000.
Under 500 .	26,529	2139	8·1
500 to 1000 .	8,732	855	9·8
1000 to 1500 .	14,463	1887	13·0
1500 to 2000 .	10,446	969	9·3
2000 and above	5,706	402	7·0
	65,876	6252	9·5

TABLE 10.—*Mortality of persons employed in steam-vessels registered in the United Kingdom, from wrecks, casualties, etc., at sea, in the* 10 *years* 1886-1895.

Tonnage.	Average No. employed.	Deaths reported.	Death-rate per 1000.
Under 500 .	23,180	777	3·4
500 to 1000 .	26,291	819	3·1
1000 to 1500 .	33,913	1591	4·7
1500 to 2000 .	22,904	695	3·0
2000 to 2500 .	16,641	324	1·9
2500 and above	22,085	202	·9
	145,014	4408	3·0

These tables are, I think, of considerable interest. Table 10 shows that the average death-rate in steamships from wrecks and casualties at sea is 3 per 1000, being about half the death-rate from accidents of all kinds as shown by Table 8. It will be seen that, for steam-vessels above 1000 tons, the death-rate steadily decreases as the size of the vessel increases, until for vessels of 2500 tons or more it is under 1 per 1000.

It has been mentioned that the number of persons employed, as given in Tables 6-10 inclusive, consists of the number of men required to man the vessels which were returned as employed some time during the year. A certain number of these vessels must have been out of employment for some portion of the year; and the number stated in the employed column, must thus be in excess of the number of persons continuously employed throughout the year. Tables are given in the Navigation Returns, which show, for the year 1888 and subsequently, the number of persons employed in merchant vessels registered in the United Kingdom, at four dates in each year, namely, 15th March, 15th June, 15th September, and 15th December. By taking the average of these four numbers for each year, we get a figure representing more correctly the number of men continuously employed throughout the year. By comparing the average number employed during the eight years 1888-95, ascertained in this way, with the corresponding number obtained according to the method followed in the Registrar-General's table, we find that the latter is 13·1 per cent. greater in the case of sailing-vessels, 16·9 per cent. greater in the case of steamships, and 15·8 per cent. greater in the case of sailing and steam vessels combined.

I have made up other two tables, similar to Tables 9 and 10, in which the number of men employed is calculated according to the more correct method last described.

TABLE 11.—*Mortality of persons employed in sailing-vessels registered in the United Kingdom, from wrecks, casualties, etc., at sea, in the* 8 *years* 1888-1895.

Tonnage.	Average No. employed.	Deaths reported.	Death-rate per 1000.
Under 500 .	23,078	1723	9·3
500 to 1000 .	6,550	580	11·1
1000 to 1500 .	11,734	1433	15·3
1500 to 2000 .	9,274	741	10·0
2000 and above	5,289	396	9·4
	55,925	4873	10·9

TABLE 12.—*Mortality of persons employed in steam-vessels registered in the United Kingdom from wrecks, casualties, etc., at sea, in the* 8 *years* 1888-95.

Tonnage.	Average No. employed.	Deaths reported.	Death-rate per 1000.
Under 500 .	20,013	534	3·3
500 to 1000 .	22,765	650	3·6
1000 to 1500 .	29,516	1165	4·9
1500 to 2000 .	20,459	644	3·9
2000 to 2500 .	14,307	283	2·5
2500 and above	18,509	166	1·1
	125,569	3442	3·4

It will be observed that, in the case of sailing-vessels, there is a material difference between the death-rates in Tables 9 and 11, the rate over all being 10·9 per 1000 in the latter, against 9·5 per 1000 in the former; although, as appears from Table 6, the average death-rate during the 10 years ending 1895, was heavier than the corresponding rate during the 8 years ending 1895. In the case of steam-vessels, the average rate is 3·4 per 1000 in Table 12, against 3 per 1000 in Table 10. In the case of both sailing and steam vessels the rates run more smoothly in Tables 11 and 12.

Table 13 shows the rates of mortality among merchant seamen during the forty years ending 1895, compared with that of the Institute H^M Table. It is made up from the information given in the Registrar-General's Table referred to above, the expected death-rates being calculated from the information in the census returns. The figure for 1895 is included for the purpose of comparison. It will be seen that, for the last two periods, and especially for the last period, the mortality shows a great reduction.

TABLE 13.—*Mortality among Seamen employed in merchant vessels registered in the United Kingdom.*

10 years ending 31st Dec.	Average number employed.	Deaths reported.	Death-rate per 1000.	Expected death-rate Institute H^M Table.	Excess of actual over expected death-rate.
1865	179,618	36,742	20·5	8·1	12·4
1875	199,064	47,273	23·8	8·1	15·7
1885	196,531	40,611	20·7	10·2	10·5
1895	231,891	33,099	14·2	9·2	5·0

The tables given above relate to men of all ratings in the merchant service. With the view of ascertaining what difference there is between the mortality of masters and that of the general body, I applied to the Registrar-General of Shipping and Seamen, to know whether there were any official statistics bearing on the subject. That gentleman most kindly furnished me with a table containing the only figures in his possession relating to the mortality of masters. From these figures, I have prepared the following Table 14.

TABLE 14.—*Mortality from violence, accident, etc., among persons employed in sea-going merchant vessels in the United Kingdom, in the year* 1896.

Rating.	Sailing.			Steam.		
	Employed.	Deaths reported.	Death-rate per 1000.	Employed.	Deaths reported.	Death-rate per 1000.
Masters .	6,520	60	9·2	5,635	23	4·1
Other ratings	48,090	699	14·5	123,520	903	7·3
Total . .	54,610	759	13·9	129,155	926	7·2

Table 14 shows that, if the experience of the year 1896 can be taken as a safe guide, the death-rate among masters is decidedly lighter than among men, the rates being 4·1 per 1000 for masters, against 7·3 for men, and 7·2 for all ratings.

The information supplied by the Registrar-General of Shipping, has also enabled me to give the following Table 15, which shows

the comparative mortality in the home and foreign trades respectively. By the home trade, is to be understood trade within the limits of the British Islands and the Continent of Europe between the river Elbe and Brest. Foreign trade is trade beyond these limits.

TABLE 15.—*Mortality from violence, accident, etc., among persons employed in sea-going merchant vessels registered in the United Kingdom, in the year* 1896.

Trade.	Sailing.			Steam.		
	Employed.	Deaths reported.	Death-rate per 1000.	Employed.	Deaths reported.	Death-rate per 1000.
Home .	17,185	151	8·8	25,105	105	4·2
Foreign .	37,425	608	16·2	104,050	821	7·9
	54,610	759	13·9	129,155	926	7·2

Table 15 shows that, taking the experience of the year 1896, the mortality from violence, accident, etc., in the foreign trade, is, roughly speaking, double the corresponding mortality in the home trade.

The information given in Tables 8-14, seems to lead to the following conclusions, namely:—

(1) The death-rate in the whole merchant service from all causes taken together, has greatly diminished during the last 20 years, and especially during the latter part of that period.

(2) The death-rate from wrecks, casualties, and other accidents, in trading vessels, is about 10 per 1000.

(3) It is much lighter for steamships than for sailing-vessels, being about 7 per 1000 for the former, against 17 per 1000 for the latter.

(4) About one-half the total death-rate from wrecks, casualties, and other accidents, is due to wrecks and casualties occurring at sea. The death-rate under this last head in both sailing and steam vessels, increases with the size of the vessels up to vessels of 1000 and 1500 tons, and thereafter diminishes rapidly, in the case of steam-vessels of 2500 tons or more, to 1·1 per 1000.

(5) The mortality of masters is substantially less than that of seamen.

FISHERMAN.

TABLE 16.—*Mortality*, 1890-91-92, *in occupation of Fisherman.*

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in heavy labour with exposure.	Assured Lives Institute H^M.
25–35	18,843	172	9·13	1·84	1·80	1·58
35–45	13,965	148	10·60	– 1·83	– 1·71	·43
45–55	9,510	177	18·61	– 2·05	– ·60	2·89
55–65	6,003	154	25·65	– 11·01	– 7·16	– 3·76

The death-rates shown by Table 16 are very light: but there is, in the case of this occupation, a somewhat serious discrepancy between the Registrar-General's figures, and those of the Board of Trade.

Table 8 shows that the deaths by wrecks, casualties, and other accidents, among fishermen of all ages, have, on the average of the 10 years ending 1895, been at the rate of 14·8 per 1000. Taking sailing and steam vessels separately, the rates are 16·5 per 1000 for the former, and 7·7 per 1000 for the latter. There is a startling discrepancy between these rates, and the death-rates by accident as given in Table 4, which vary between 2·00 and 2·71 per 1000. Dr. Tatham points out the need of caution in accepting the Registrar-General's figures relating to this occupation, both as regards the living and the dead. Besides the regular and permanent fishermen, there is, he says, also a considerable number of men who engage irregularly in the fishing industry; and there is no certainty how such men may have returned themselves at the census. Again, referring to the deaths, Dr. Tatham says: 'Very 'occasionally it happens that the bodies of fishermen are not 'recovered after drowning: in these cases it is possible that the 'deaths may escape registration.' This cause of error may possibly operate to a larger extent than is here supposed. In the absence of further information, I think it must be assumed that the percentages derived from Table 8 give the more correct indication of the risk of fatal accident in this occupation.

It is to be observed, however, that the figures in Table 8 refer to men employed in registered fishing-vessels. Only about one half of the fishing-vessels of fifteen tons and upwards, are registered.

Table 17 relates to the comparative mortality of masters and men. It is prepared from the information furnished by the Registrar-General of Shipping and Seamen, referred to above.

TABLE 17.—*Mortality from violence, accident, etc., of persons employed in fishing-vessels registered in the United Kingdom, in the year* 1896.

Rating.	Sailing.			Steam.		
	Employed.	Deaths reported.	Death-rate per 1000.	Employed.	Deaths reported.	Death-rate per 1000.
Masters .	2,664	11	4·13	753	3	3·98
Other ratings	11,500	103	8·96	5861	41	7·00
Total . .	14,164	114	8·05	6614	44	6·65

It will be seen that, judging by the experience of the year 1896, the mortality of masters from accident is much lower than that of men of all ratings taken together.

RAILWAY ENGINE DRIVER, STOKER.

TABLE 18.—*Mortality,* 1890-91-92, *in occupation of Railway Engine Driver, Stoker.*

Ages.	Years of life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in light labour with exposure.	Assured Lives Institute H^m.
25–35	37,503	204	5·44	−1·85	−1·02	−2·11
35–45	24,819	179	7·21	−5·22	−4·09	−2·96
45–55	11,433	184	16·09	−4·57	−1·77	·37
55–65	4,098	174	42·46	5·80	10·81	13·05

It will be seen that the death-rate up to age 55 is light, but that at ages 55-65, it rises at once to 10·81 per 1000 in excess of that among males occupied in light labour with exposure to the weather. The following Table 19 shows that the cause of this excessive mortality, is liability, at these ages, to diseases of the nervous and circulatory systems. The liability to accident is, comparatively speaking, unimportant, the death-rate from this cause varying from 1·01 to 2·20 per 1000.

TABLE 19.—*Mortality among Railway Engine Drivers, Stokers, from certain specified causes,* 1890-91-92, *compared with corresponding mortality among Occupied Males.*

Cause of death.	Death-rate per 1000.				Number of deaths corresponding to each 100 among occupied males.			
	Ages.				Ages.			
	25 to 35.	35 to 45.	45 to 55.	55 to 65.	25 to 35.	35 to 45.	45 to 55.	55 to 65.
Phthisis	1·23	1·01	1·92	·73	47	30	57	28
Diseases of nervous system	·45	·60	1·92	8·30	125	73	105	192
,, ,, circulatory ,,	·35	·89	2·71	9·76	62	66	94	155
,, ,, respiratory ,,	·64	1·41	3·41	8·78	56	56	66	85
Accident . . .	1·15	1·01	1·31	2·20	174	120	120	155

The following Table 20 is made up from the Reports on Railway Accidents issued by the Board of Trade. It shows that the death-rate among engine drivers and firemen of all ages, arising from fatal accidents, has, on the average of the five years ending 1896, been 1·32 per 1000. The rate appears to have been steadily decreasing. In 1870-72 it was 5·06. During the first two years of the period covered by Table 20, it was 1·52; during the last two years, 1895-96, it was 1·09. In 1896 a new rule was introduced by the Board of Trade, as to non-fatal accidents, which has considerably increased the number of injuries reported.

TABLE 20.—*Number of men employed by the Railway Companies of the United Kingdom as Engine Drivers and Firemen, and the number of fatal accidents and injuries to each class.*

Year.	Engine Drivers.			Firemen.		
	Number employed.	Fatal Accidents.	Injuries.	Number employed.	Fatal Accidents.	Injuries.
1892	15,180	33	327	14,804	20	421
1893	15,180	25	285	14,804	13	386
1894	15,180	16	260	14,804	29	398
1895	19,281	22	239	19,264	30	361
1896	19,281	13	705	19,264	19	966
Total	84,102	109	1816	82,940	111	2532

RAILWAY GUARD, PORTER, POINTSMAN, ETC.

TABLE 21.—*Mortality*, 1890-91-92, *in occupation of Railway Guard, Porter, Pointsman, etc.*

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in light labour with exposure.	Assured Lives Institute H^M
25–35	97,425	628	6·45	– ·84	– ·01	– 1·10
35–45	67,584	621	9·19	– 3·24	– 2·11	– ·98
45–55	34,848	602	17·28	– 3·38	– ·58	1·56
55–65	14,331	509	35·52	– 1·14	3·87	6·11

Table 22 is made up from information given in the Reports of the Board of Trade

TABLE 22.—*Number of men employed by the Railway Companies of the United Kingdom as Guards and Porters, and the number of fatal accidents and injuries to each class.*

Year.	Brakesmen and Goods Guards.			Guards (Passenger).			Porters.		
	Number employed.	Fatal Accidents	Injuries.	Number employed.	Fatal Accidents	Injuries.	Number employed.	Fatal Accidents	Injuries.
1892	10,038	45	467	5,033	8	84	38,808	75	397
1893	10,038	39	473	5,033	5	60	38,808	56	356
1894	10,038	45	464	5,033	9	71	38,808	61	376
1895	11,881	35	487	6,357	2	77	45,696	49	398
1896	11,881	36	984	6,357	4	137	45,696	62	3616
Total	53,876	200	2875	27,813	28	429	207,816	303	5143

Here, the death-rates at the various groups of ages show the same features as in the case of engine drivers and stokers, but these are not so strongly marked. Up to age 55 the death-rate is light; but at ages 55-65, it exceeds that of males occupied in light labour with exposure to the weather, by 3·87 per 1000. At these ages the death-rate from accident rises to 3·91 per 1000, being 176 per cent. above the rate for occupied males. Making use of the figures given in Table 22, we find that, taking all ages, the death-rate per 1000 from fatal accidents, has, on the average of the five years ending 1896, been as follows:—

Brakesmen and goods guards . . .	3·71
Guards (passenger)	1·01
Porters	1·46

The rate in 1870-72 among persons classed as Railway attendant, servant, was 4·99.

COAL MINER.

Tables 23 to 25 relate to the mortality of coal miners. The rates for the general body, as given in Tables 23 and 24, are, as Dr. Ogle has remarked, surprisingly low.

TABLE 23.—*Mortality*, 1890-91-92, *in occupation of Coal Miner.*

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in heavy labour without exposure.	Assured Lives Institute H^M.
25–35	380,355	2391	6·29	−1·00	− ·69	−1·26
35–45	265,098	2552	9·63	−2·80	−2·49	− ·54
45–55	162,981	3165	19·42	−1·24	−3·29	3·70
55–65	80,403	3521	43·79	7·13	−1·16	14·38

TABLE 24.—*Mortality among Coal Miners from certain specified causes*, 1890-91-92, *compared with corresponding mortality among Occupied Males.*

Cause of death	Death-rate per 1000.				Number of deaths corresponding to each 100 among occupied males.			
	Ages.				Ages.			
	25 to 35.	35 to 45.	45 to 55.	55 to 65.	25 to 35.	35 to 45.	45 to 55.	55 to 65.
Phthisis	1·21	1·42	2·07	2·23	46	41	61	84
Diseases of nervous system	·29	·56	1·37	3·92	81	67	75	90
,, ,, respiratory ,,	·92	2·11	5·70	16·48	81	84	111	160
Accident	1·83	2·11	2·91	3·07	278	250	265	217

TABLE 25.—*Mortality*, 1890-91-92, *in occupation of Coal Miner (Monmouthshire and South Wales).*

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in heavy labour without exposure.	Assured Lives Institute H^M.
25–35	80,598	691	8·57	1·28	1·59	1·02
35–45	49,035	592	12·07	– ·36	– ·05	1·90
45–55	29,466	715	24·27	3·61	1·56	8·55
55–65	14,622	752	51·43	14·77	6·48	22·02

It will be seen that the death-rate of coal miners at ages 55-65, is only 1·16 per 1000 above the corresponding rate among the general body of males engaged in heavy labour without exposure to the weather. It must be remembered, however, that the latter rate is much heavier than the rate for any of the other classes of males in Table 1. The death-rate among coal miners at ages 55-65, exceeds the Institute H^M rate by 14·38 per 1000. Coal miners in Monmouthshire and South Wales are subject to a specially heavy mortality from accident, as shown in Table 4. The death-rate from accident among all coal miners above fifteen, was in 1890-92, 2·00 per 1000. In 1870·72 it was 3·79.

Valuable statistics relating to persons employed and accidents at mines in the United Kingdom, are given in the reports issued by the Home Office. The following Table 26 is made up from information contained in the General Report and Statistics (Mines and Quarries) 1897.

TABLE 26.—*Death-rate per* 1000 *from accidents of various kinds among persons employed underground during the* 5 *years* 1891-1895.

Explosions of fire-damp or coal-dust	·244
Falls of ground	·798
In shafts	·193
Miscellaneous	·470
Total	1·705

During the same period, the death-rate from accident among persons employed about mines above ground, was ·820 per 1000, and the rate among those employed above and underground taken together, was 1·524 per 1000.

In 1897, 93½ per cent. of all the persons employed in and about mines were working at collieries.

Ironstone Miner.

Table 27.—*Mortality*, 1890-91-92, *in occupation of Ironstone Miner.*

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in heavy labour without exposure.	Assured Lives Institute H^M.
25–35	13,791	82	5·95	−1·34	− 1·03	−1·60
35–45	12,216	100	8·19	−4·24	− 3·93	−1·98
45–55	8,385	143	17·05	−3·61	− 5·66	1·33
55–65	3,696	123	33·28	−3·38	−11·67	3·87

The death-rate among ironstone miners is very light. It appears from Table 3, that their mortality from every one of the causes mentioned in that table, is less than that of occupied males, except in the case of influenza and accident.

Slater, Tiler.

Table 28.—*Mortality*, 1890-91-92, *in occupation of Slater, Tiler.*

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in heavy labour with exposure.	Assured Lives Institute H^M.
25–35	5724	63	11·01	3·72	3·68	3·46
35–45	5067	87	17·17	4·74	4·86	7·00
45–55	3087	85	27·53	6·87	8·32	11·81
55–65	1611	81	50·28	13·62	17·47	20·87

Table 21 shows that the death-rate at all ages is heavy, rising at ages 55-65, to 17·47 per 1000 above that of males occupied in heavy labour with exposure to the weather. Table 2 shows a heavy mortality, as compared with occupied males, from phthisis, from diseases of the circulatory system, from diseases of the respiratory system, and from accident. The death-rate from accident, taking all ages above fifteen, was in 1890-92, 1·89 per 1000. In 1870-72 it was ·99 per 1000 only.

Manufacturing Chemist.

Table 29.—*Mortality*, 1890-91-92, *in occupation of Manufacturing Chemist.*

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in heavy labour without exposure.	Assured Lives Institute H^M.
25–35	15,759	133	8·44	1·15	1·46	·89
35–45	13,137	219	16·67	4·24	4·55	6·50
45–55	8,979	272	30·29	9·63	7·58	14·57
55–65	4,302	269	62·53	25·87	17·58	33·12

This class includes a considerable number of wholesale chemists and druggists, who are in the position of proprietors and managers, together with workers who are engaged in the grinding and manufacturing of drugs, and in the preparation of chemical products used in the processes of printing and dyeing wool, cotton, and other fabrics. The comparative mortality figure, 1392, is the highest in this class of occupations. The mortality from diseases of the nervous system exceeds that of occupied males by 20 per cent. In the case of diseases of the circulatory system, the excess is 33 per cent., in diseases of the respiratory system it is 127 per cent., and in the case of accident it is 74 per cent.

Class II.—Occupations involving the inhalation of dust-laden air.

We now come to the second class of occupations, namely, those which expose persons following them to the evil effects of inhaling dust-laden air. The following Table 30 contains the occupations to be dealt with under this head, with certain of the comparative mortality figures relating to them.

TABLE 30.—*Occupations involving the inhalation of Dust-Laden Air. Comparative Mortality Figures,* 1890-91-92.

Occupation.	All causes.	Phthisis.	Diseases of the respiratory system.	Plumbism.
Occupied Males . . .	**953**	**185**	**221**	**1**
Cutler, Scissors Maker .	1516	382	518	3
File Maker	1810	402	423	75
Potter, Earthenware, etc., Manufacturer . . .	1706	333	668	17
Glass Manufacture . .	1487	295	445	12
Cotton, Flax, Linen Manufacture (Lancashire) .	1176	200	365	0
Bricklayer, Mason, Builder	1001	225	251	0

Table 31 is similar to Table 3, and shows, for the occupations in Class II., the mortality from different causes, compared with that among all occupied males.

TABLE 31.—*Occupations involving the inhalation of Dust-Laden Air. Mortality from the various causes,* 1890-91-92, *compared with that among Occupied Males.*

Cause of death.	Occupied Males.	Cutler, scissors maker.	File maker.	Potter, earthenware, etc., manufacturer.	Glass manufacture.	Cotton, flax, linen manufacture (Lancashire).	Bricklayer, mason, builder.
All causes	100	159	190	179	156	123	105
Influenza	100	73	121	127	103	115	97
Alcoholism	100	138	31	69	185	69	77
Rheumatic Fever	100	100	0	114	143	143	86
Gout	100	0	200	50	450	0	150
Cancer	100	130	89	80	123	80	102
Phthisis	100	206	217	180	159	108	122
Diabetes	100	100	171	129	300	114	100
Diseases of nervous system . .	100	111	259	150	189	150	101
Diseases of circulatory system .	100	133	162	180	125	119	103
Diseases of respiratory system .	100	234	191	302	201	165	114
Diseases of the Liver . . .	100	100	133	119	111	100	85
Other diseases of digestive system .	100	111	129	121	132	143	79
Diseases of urinary system . .	100	137	254	154	154	102	90
Accident (including Plumbism) .	100	61	200	65	125	46	95
Suicide	100	207	221	114	121	136	71
All other causes	100	102	226	105	98	127	95

It will be seen that the principal feature of the mortality in this class of occupations, is the liability (sometimes excessive) to

death from phthisis or diseases of the respiratory system. The main cause of this is well known to be the inhalation of dust of one kind or another. In the case of several of the occupations, as will be seen, there is liability to lead-poisoning as well.

CUTLER, SCISSORS MAKER.

Tables 32 and 33 relate to this occupation. At ages above 35, the death-rate is heavy. At the three age-periods between 35 and 65, the mortality from phthisis is represented by the figures 234, 229, and 305, respectively, the mortality of occupied males being represented by 100. The corresponding figures for diseases of the respiratory system, are 193, 252, and 273.

TABLE 32.—*Mortality,* 1890-91-92, *in occupation of Cutler, Scissors Maker.*

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in heavy labour without exposure.	Assured Lives Institute H^M.
25–35	11,619	99	8·52	1·23	1·54	·97
35–45	9,963	208	20·88	8·45	8·76	10·71
45–55	7,866	280	35·60	14·94	12·89	19·88
55–65	4,086	246	60·21	23·55	15·26	30·80

TABLE 33.—*Mortality among Cutlers, Scissors Makers, from certain specified causes,* 1890-91-92, *compared with corresponding mortality among Occupied Males.*

Cause of death.	Death-rate per 1000.				Number of deaths corresponding to each 100 among occupied males.			
	Ages.				Ages.			
	25 to 35.	35 to 45.	45 to 55.	55 to 65.	25 to 35.	35 to 45.	45 to 55.	55 to 65.
Cancer	...	·70	1·40	3·18	...	202	124	122
Phthisis	3·27	8·03	7·75	8·08	125	234	229	305
Diseases of circulatory system	·95	2·51	4·07	5·87	170	188	140	93
,, ,, respiratory ,,	1·46	4·82	12·96	28·14	129	193	252	273
,, ,, urinary ,,	·26	·40	1·27	3·18	116	83	131	173

File Maker.

Tables 34 and 35 refer to file makers. Persons in this occupation are subject to a still heavier mortality than cutlers and scissors makers. The causes of the extra mortality in this occupation, have been very fully investigated by a departmental committee, appointed by the Home Secretary to inquire into certain miscellaneous dangerous trades. The following statement of the dangers of the work, is extracted from the third interim report of the committee dated 28th August last:—'The dangers 'of file cutting are to be traced to several causes, the most 'important of which is the "lead bed." But there are many 'accessories to this, which make file cutting one of the most 'serious subjects into which the Committee have been directed to 'inquire. The conditions under which the occupation is carried 'on in numerous instances, tend unnecessarily to aggravate the 'risks of lead-poisoning.

'Bad ventilation, overcrowding, dirtiness, want of light in the 'workshops, their close proximity to privy middens, general dis-'inclination to take precautions, the cramped position in which 'the work is carried on, the practice of licking the fingers to hold 'the chisel and of brushing the dust off the cut file, the juxta-'position of the "stocks" [a stone block at which the worker is 'seated], dilapidation of the floors, and neglect of lime-washing, 'are governing conditions which produce in this industry, a 'vitality as low and a mortality as high, as can be found in any 'industry considered by the Committee.

'With so little space between the workers, it is inevitable, under 'existing conditions, that they should inhale the dust created by 'the constant hammering and brushing of files. This dust 'contains a large proportion of lead, as well as chalk, charcoal, 'steel, and granite, and is found on the floor, and on the "stocks." 'Even in the dust removed from the rafters, careful analysis 'discloses the presence of lead. Workers in so sedentary an 'occupation, naturally object to the draught caused by the opening 'of windows immediately in front of or beside them. In the 'absence of other means of admitting fresh air, there is practically 'no ventilation.'

It will be seen that, in addition to the heavy mortality from phthisis and diseases of the respiratory system, and from lead-poisoning, file makers are specially liable to diseases of the nervous and circulatory systems, and, at certain ages, to diseases of the liver, the digestive and urinary systems. Dr. Ogle expresses the opinion, that a considerable share in all this mortality is due to lead; and it is to be observed that, taking the deaths of 1890-91-92, lead-workers show a higher mortality from diseases of the nervous

system, of the circulatory system and of the urinary system, respectively, than persons of any other occupation (see Dr. Tatham's Table V.). Further, excepting certain classes of innkeepers, they show a higher mortality from diseases of the liver and other diseases of the digestive system, than persons of any other occupation.

TABLE 34.—*Mortality*, 1890-91-92, *in occupation of File Maker.*

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in heavy labour without exposure.	Assured Lives Institute H^M.
25–35	5049	56	11·09	3·80	4·11	3·54
35–45	4632	121	26·12	13·69	14·00	15·95
45–55	3345	134	40·06	19·40	17·35	24·34
55–65	1596	113	70·80	34·14	25·85	41·39

Table 35 shows how the mortality of the years 1890-91-92, compares with that ascertained from the census returns and registers of death in former years.

TABLE 35.—*Occupation of File Maker—Excess of death-rate per* 1000 *in certain years, over that to be expected according to the Institute H^M Table.*

Ages.	1851.	1860-61.	1871.	1880-81-82.	1890-91-92.
25–35	...	3·6	9·8	6·5	3·5
35–45	...	8·7	11·8		16·0
45–55	9·3	24·4	13·9	23·3	24·3
55–65	36·8	22·5	35·3		41·4

POTTER, EARTHENWARE, ETC., MANUFACTURER.

TABLE 36.—*Mortality*, 1890-91-92, *in occupation of Potter, Earthenware, etc., Manufacturer.*

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in light labour without exposure.	Assured Lives Institute H^M.
25–35	23,454	192	8·19	·90	·90	·64
35–45	17,061	334	19·58	7·15	7·26	9·41
45–55	11,451	492	42·97	22·31	22·32	27·25
55–65	5,031	378	75·13	38·47	37·72	45·72

This occupation shows an excessively high mortality, principally at ages above 45. Besides the heavy mortality from phthisis and diseases of the respiratory system, there is a liability to lead-poisoning, and a heavy death-rate from diseases of the circulatory and urinary systems. Dr. Ogle says that the various processes of the manufacture differ very greatly as regards their unhealthiness; but, taking the aggregate industry, the two main conditions that produce the high mortality, are the inhalation of air charged with fine, irritating dust, and exposure to great vicissitudes of temperature.

Public attention has lately been drawn to the subject of lead-poisoning in the Potteries, and special rules for the industry under the Factory Act of 1891, have been laid down. The processes which involve the risk of lead-poisoning, are principally those connected with glazing and colouring. Certain branches of the trade, however, have little to do with them. The Special Correspondent of the *Times*[1] gives the case of 31 firms of China manufacturers at Longton. The average length of time they have been in business is 21 years, and the average number of hands employed 110. Only 3 cases of lead-poisoning occurred in every 1000 workers during the 21 years.

[1] 18th October 1898.

Glass Manufacture.

Table 37.—*Mortality*, 1890-91-92, *in occupation of Glass Manufacture.*

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in heavy labour without exposure.	Assured Lives Institute H^M.
25–35	15,642	177	11·32	4·03	4·34	3·77
35–45	11,634	208	17·88	5·45	5·76	7·71
45–55	6,876	221	32·14	11·48	9·43	16·42
55–65	2,994	182	60·79	24·13	15·84	31·38

The death-rates in this occupation are high. Glass-making, Dr. Ogle says, is carried on in an excessively high temperature; and, in some of the operations, fine hard and sharp-pointed dust is given off. Table 37 shows a relatively high mortality at ages under 35.

Cotton, Flax, Linen Manufacture (Lancashire).

Table 38.—*Mortality*, 1890-91-92, *in occupation of Cotton, Flax, Linen Manufacture* (*Lancashire*).

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in light labour without exposure.	Assured Lives Institute H^M.
25–35	111,243	793	7·13	– ·16	– ·16	– ·42
35–45	71,022	950	13·38	·95	1·06	3·21
45–55	43,881	1102	25·11	4·45	4·46	9·39
55–65	21,342	1175	55·06	18·40	17·65	25·65

Dr. Ogle says, that the air in the weaving sheds of cotton factories contains not only flocculent matter, but also a large amount of dust from mineral substances of various kinds used in sizing; and that the inhalation of mineral substances, is much more injurious than the inhalation of textile filaments; also that the deleterious effects of the dust upon the air passages, is increased by the high temperature in which the work is carried on.

Bricklayer, Mason, Builder.

Table 39.—*Mortality*, 1890-91-92, *in occupation of Bricklayer, Mason, Builder.*

Ages.	Years of life.	Deaths	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in heavy labour with exposure.	Assured Lives Institute H^M.
25–35	194,925	1276	6·55	- ·74	- ·78	- 1·00
35–45	180,468	2427	13·45	1·02	1·14	3·28
45–55	124,950	2754	22·04	1·38	2·83	6·32
55–65	70,488	2836	40·23	3·57	7·42	10·82

Bricklayers, masons and builders are, (Dr. Ogle says), of course exposed by the nature of their work, to the inhalation of dust, but in a mitigated degree, inasmuch as their work is carried on mainly in the open air; and consequently their mortality is somewhat high from phthisis and diseases of the respiratory organs, but not excessively so. This is borne out by the figures in the following Table 40. At ages under 35, the mortality from phthisis is 12 per cent. under that of occupied males; at ages above 35, it is from 33 to 51 per cent. above it. In the case of diseases of the respiratory system, the mortality at ages under 35, is 5 per cent. under that of occupied males; at ages above 35, it is from 10 to 22 per cent. above it.

Table 40.—*Mortality among Bricklayers, Masons, Builders, from certain specified causes*, 1890-91-92, *compared with corresponding mortality among Occupied Males.*

Cause of death.	Death-rate per 1000.				Number of deaths corresponding to each 100 among occupied males.			
	Ages.				Ages.			
	25 to 35.	35 to 45.	45 to 55.	55 to 65.	25 to 35.	35 to 45.	45 to 55.	55 to 65.
Phthisis	2·30	4·55	4·67	4·02	88	133	138	151
Diseases of respiratory system	1·08	3·04	5·67	12·16	95	122	110	118

Class III.—Occupations involving liability to lead-poisoning.

Of the third class of occupations—those which involve liability to lead-poisoning—the principal are included in the following Tables 41 and 42.

TABLE 41.—*Occupations involving the risk of Lead-Poisoning—Comparative Mortality Figures* 1890-91-92.

Occupation.	All causes.	Diseases of nervous system.	Diseases of circulatory system.	Diseases of digestive system.	Diseases of urinary system.	Plumbism.
Occupied Males . . .	**953**	**82**	**126**	**55**	**41**	**1**
Lead Worker	1783	232	272	147	161	211
File Maker	1810	212	204	72	104	75
Plumber, Painter, Glazier .	1120	131	142	53	84	19
Potter, Earthenware, etc., Manufacturer	1706	123	227	66	63	17
Glass Manufacture . . .	1487	155	157	67	63	12

TABLE 42.—*Occupations involving the risk of Lead-Poisoning—Mortality from the various causes,* 1890-91-92, *compared with that among Occupied Males.*

Cause of death.	Occupied males.	Lead worker.	File maker.	Plumber, painter, glazier.	Potter, earthenware, etc., manufacturer.	Glass manufacture.
All causes	100	187	190	118	179	156
Influenza	100	97	121	88	127	103
Alcoholism	100	0	31	100	69	185
Rheumatic Fever	100	0	0	129	114	143
Gout	100	0	200	500	50	450
Cancer	100	61	89	120	80	123
Phthisis	100	80	217	117	180	159
Diabetes	100	0	171	86	129	300
Diseases of nervous system . .	100	283	259	160	150	189
Diseases of circulatory system .	100	216	162	113	180	125
Diseases of respiratory system .	100	180	191	101	302	201
Diseases of the Liver . . .	100	296	133	81	119	111
Other diseases of digestive system .	100	239	129	111	121	132
Diseases of urinary system . .	100	393	254	205	154	154
Accident (including Plumbism) .	100	449	200	125	65	125
Suicide	100	93	221	114	114	121
All other causes	100	148	226	94	105	98

It will be seen that the five occupations in Tables 41 and 42 involve, together with liability to lead-poisoning, exceptional liability to diseases of the nervous, circulatory, and urinary systems, and in four out of the five, to diseases of the digestive system as well. The occupations of File maker, Potter, Earthenware, etc., manufacturer, and Glass manufacture, have been dealt with under the last head. Those of Lead worker and Plumber, Painter, Glazier, remain.

Lead Worker.

Table 43.—*Mortality*, 1890-91-92, *in occupation of Lead Worker.*

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in heavy labour without exposure.	Assured Lives Institute H^M.
25–35	1236	15	12·14	4·85	5·16	4·59
35–45	1317	30	22·78	10·35	10·66	12·61
45–55	957	36	37·62	16·96	14·91	21·90
55–65	624	47	75·32	38·66	30·37	45·91

Table 43 shows an excessively high rate of mortality at all ages. The numbers enumerated and number of deaths are, however, small.

Plumber, Painter, Glazier.

Table 44.—*Mortality*, 1890-91-92, *in occupation of Plumber, Painter, Glazier.*

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among	
				All Occupied Males.	Assured Lives Institute H^M.
25–35	137,073	965	7·04	– ·28	– ·51
35–45	108,831	1610	14·79	2·36	4·62
45–55	68,199	1714	25·13	4·47	9·41
55–65	32,253	1470	45·58	8·92	16·17

TABLE 45.—*Mortality among Plumbers, Painters, Glaziers, from certain specified causes,* 1890-91-92, *compared with corresponding mortality among Occupied Males.*

Cause of death.	Death-rate per 1000. Ages.				Number of deaths corresponding to each 100 among occupied males. Ages.			
	25 to 35.	35 to 45.	45 to 55.	55 to 65.	25 to 35.	35 to 45.	45 to 55.	55 to 65.
Phthisis	2·73	4·12	3·99	3·81	104	120	118	144
Diseases of nervous system	·34	1·36	3·23	7·04	92	164	177	163
,, ,, circulatory ,,	·66	1·77	3·34	6·36	118	133	115	101
,, ,, urinary ,,	·28	·97	2·20	3·78	128	201	227	205
Plumbism . . .	·13	·32	·56	·34	1717	1872	2169	2079

Table 44 shows a considerable extra mortality, especially at the higher ages. The death-rate from phthisis is shown by Table 42, to be 17 per cent. above that for occupied males. Dr. Tatham states that separate examination of the returns relating to plumbers on the one hand, and painters and glaziers on the other, shows very little difference in the liability of these workers to lead-poisoning. The difference, such as it is, is slightly unfavourable to plumbers; but there are so many workers who follow both occupations, that any comparison between the respective death-rates would, he considers, be of doubtful utility.

Table 46 shows how the death-rates of 1890-91-92 compare with those of former years.

TABLE 46.—*Occupation of Plumber, Painter, Glazier—Excess of death-rate per* 1000 *in certain years, over that to be expected according to the Institute* H^M *Table.*

Ages.	1851.	1860-61.	1871.	1880-82.	1890-92.
25–35	2·1	1·4	2·6	2·3	...
35–45	6·5	5·5	7·8		4·6
45–55	14·4	11·4	13·3	10·7	9·4
55–65	16·1	20·2	18·7		16·2

Class IV.—Occupations involving temptation to alcoholic excess.

I do not propose to go with any minuteness into the mortality in the fourth group of occupations, namely, those involving the temptation to alcoholic excess, as the more important part of the subject has been frequently investigated by competent authorities; but the statistics given by the Registrar-General, show so strongly the serious nature of the extra risk involved in insurances on the lives of persons engaged in the liquor trade, that I have thought it desirable to give a sample of them. I shall deal with the occupations mentioned in the following Tables 47 and 48.

TABLE 47.—*Occupations involving temptation to Alcoholic Excess—Comparative Mortality Figures,* 1890-91-92.

Occupation.	All causes.	Alcoholism.	Phthisis.	Diseases of nervous system.	Diseases of circulatory system.	Diseases of respiratory system.	Diseases of Liver.	Other diseases of digestive system.	Diseases of urinary system.	Accident.	Suicide.
Occupied Males . .	**953**	**13**	**185**	**82**	**126**	**221**	**27**	**28**	**41**	**56**	**14**
Brewer	1427	41	273	125	195	315	59	47	78	50	17
Innkeeper, Servant, etc.	1659	94	311	148	190	298	174	47	86	47	29
Do. (London) .	1838	127	448	112	205	384	102	38	92	53	34
Do. (Ind. dists.) .	1948	93	314	182	221	426	217	73	85	46	27
Do. (Agric. dists.)	1348	69	230	147	166	165	169	39	91	51	21
Butcher . . .	1096	35	195	105	157	209	56	31	48	39	23

Following the example of Dr. Ogle, I include butchers in this class. They have long been known to be subject to a high mortality. Dr. Ogle says that this is manifestly due to excessive indulgence; and it will be seen that their mortality figures for alcoholism and diseases of the liver, approach very closely to those of brewers. The mortality of brewers and publicans, is higher than that of occupied males, in the case of every one of the causes of death included in Table 48, with the single exception of accident.

TABLE 48.—*Occupations involving temptation to Alcoholic Excess —Mortality from the various causes,* 1890-91-92, *compared with that among Occupied Males.*

Cause of death.	Occupied males.	Brewer.	Innkeeper, servant, etc.	Do. London.	Do. Industrial districts.	Do. Agricultural districts.	Butcher.
All causes	100	150	174	193	204	141	115
Influenza	100	139	139	158	130	161	115
Alcoholism	100	315	723	977	715	531	269
Rheumatic Fever	100	186	229	243	314	114	157
Gout	100	500	600	550	500	750	300
Cancer	100	159	120	152	134	107	130
Phthisis	100	148	168	242	170	124	105
Diabetes	100	243	271	343	300	114	186
Diseases of nervous system	100	152	181	137	222	179	128
Diseases of circulatory system	100	155	151	163	175	132	125
Diseases of respiratory system	100	143	135	174	193	75	95
Diseases of the Liver	100	219	644	378	804	626	207
Other diseases of digestive system	100	168	168	136	261	139	111
Diseases of urinary system	100	190	210	224	207	222	117
Accident (including Plumbism)	100	88	82	93	82	89	68
Suicide	100	121	207	243	193	150	164
All other causes	100	108	135	109	164	105	111

In considering the figures in Tables 47 and 48, it is necessary to keep in mind the considerations referred to in the following remarks by Dr. Ogle. He says: 'The mortality directly ascribed 'to alcoholism is, however, a very imperfect measure of the 'intemperance prevailing in different industries; for there can be no 'doubt, that the desire to spare the feelings of sorrowing relatives, 'practically limits the statement of the cause of decease to those 'cases where no disguise is possible. A better measure is the 'mortality from diseases of those organs, which are known to be 'seriously affected by alcoholic excess, and which can be stated in 'certificates of death without fear of offence. Pre-eminent among 'such organs is the liver; for, though alcoholic excess appears to 'affect injuriously every tissue and organ in the body, it is upon 'the liver that its effect is most marked.' Other diseases that may be put in the same category are gout, diseases of the nervous system, and diseases of the urinary system.

BREWER.

TABLE 49.—*Mortality*, 1890-91-92, *in occupation of Brewer.*

Ages.	Years of life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in heavy labour without exposure.	Assured Lives Institute H^M.
25–35	21,792	236	10·83	3·54	3·85	3·28
35–45	18,069	344	19·04	6·61	6·92	8·87
45–55	12,633	389	30·79	10·13	8·08	15·07
55–65	6,576	358	54·44	17·78	9·49	25·03

It will be observed that the mortality of brewers from the following causes, is greatly in excess of that of occupied males, namely:—alcoholism excess, 215 per cent.; gout, 400 per cent.; diseases of the liver, 119 per cent.; diseases of the urinary organs, 90 per cent.

INNKEEPER, INN SERVANT, ETC.

This class includes inn or hotel keepers, dealers in spirits, wine, or beer, and inn or hotel servants. Dr. Tatham says that there is evidently a somewhat steady transfer of inn servants as they grow older, to the class of innkeepers, and possibly also some confusion between employers and employed in these sections of the liquor trade. For this reason, he has seldom, in his remarks, attempted a distinction between masters and men. The following Tables 50-53 show the mortality of this class, (1) in England and Wales, (2) in London, (3) in the industrial districts, and (4) in the agricultural districts.

TABLE 50.—*Mortality*, 1890-91-92, *in occupation of Innkeeper, Servant, etc.*

Ages.	Years of life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in light labour without exposure.	Assured Lives Institute H^M.
25–35	86,850	1308	15·06	7·77	7·77	7·51
35–45	79,407	1947	24·52	12·09	12·20	14·35
45–55	64,245	2264	35·24	14·58	14·59	19·52
55–65	36,408	1918	52·68	16·02	15·27	23·27

TABLE 51.—*Mortality*, 1890-91-92, *in occupation of Innkeeper, Servant, etc.* (*London*).

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				Occupied Males (London).	Males occupied in light labour without exposure.	Assured Lives Institute H^M.
25–35	26,205	384	14·65	6·50	7·36	7·10
35–45	16,581	453	27·32	11·82	15·00	17·15
45–55	10,188	419	41·12	15·81	20·47	25·40
55–65	4,311	259	60·08	16·05	22·67	30·67

TABLE 52.—*Mortality*, 1890-91-92, *in occupation of Innkeeper, Servant, etc.* (*Industrial Districts*).

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				Occupied Males (Industrial Districts).	Males occupied in light labour without exposure.	Assured Lives Institute H^M.
25–35	18,495	333	18·00	9·35	10·71	10·45
35–45	16,965	466	27·46	11·55	15·14	17·29
45–55	12,852	555	43·18	15·36	22·53	27·46
55–65	6,807	414	60·82	10·67	23·41	31·41

TABLE 53.—*Mortality*, 1890-91-92, *in occupation of Innkeeper, Servant, etc.* (*Agricultural Districts*).

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				Occupied Males (Agricultural Districts).	Males occupied in light labour without exposure.	Assured Lives Institute H^M.
25–35	8,781	100	11·39	5·39	4·10	3·84
35–45	10,659	212	19·88	10·92	7·56	9·71
45–55	10,347	288	27·83	14·01	7·18	12·11
55–65	6,855	318	46·39	20·28	8·98	16·98

In all these groups there is very heavy mortality under the heads of alcoholism, gout, diseases of the liver, and diseases of the urinary system, as well as from phthisis and diseases of the respiratory system.

BUTCHER.

TABLE 54.—*Mortality*, 1890-91-92, *in occupation of Butcher.*

Ages.	Years of Life.	Deaths.	Death-rate per 1000.	Excess of death-rate over corresponding rate among		
				All Occupied Males.	Males occupied in light labour without exposure.	Assured Lives Institute H^M.
25–35	70,230	529	7·53	·24	·24	– ·02
35–45	46,926	735	15·66	3·23	3·34	5·49
45–55	29,931	678	22·65	1·99	2·00	6·93
55–65	16,134	699	43·32	6·66	5·91	13·91

TABLE 55.—*Mortality among Butchers from certain specified causes*, 1890-91-92, *compared with corresponding mortality among Occupied Males.*

Cause of death.	Death-rate per 1000.				Number of deaths corresponding to each 100 among occupied males.			
	Ages.				Ages.			
	25 to 35.	35 to 45.	45 to 55.	55 to 65.	25 to 35.	35 to 45.	45 to 55.	55 to 65.
Alcoholism . . .	·34	·62	·77	·68	291	248	274	302
Cancer	·03	·60	1·10	3·84	31	171	98	147
Phthisis	2·29	4·24	3·71	2·48	87	124	110	93
Diseases of circulatory system . . .	·44	1·77	3·44	8·68	79	132	119	138
Diseases of the Liver .	·13	·77	1·54	2·35	127	234	212	198

TABLE 56.—*Occupation of Butcher—Excess of death-rate per* 1000 *in certain years, over that to be expected according to the Institute* H^M *Table.*

Ages.	1851.	1860-61.	1871.	1880-82.	1890-92.
25–35	3·8	2·1	3·3	3·4	...
35–45	6·4	4·9	11·5		5·5
45–55	7.5	5·2	9·6	7·2	6·9
55–56	12·3	8·5	7·4		13·9

Table 54 shows an excess of mortality at all ages, over males occupied in light labour without exposure. The mortality from all the causes given in Table 48, is in excess of that of occupied males, with the exception of diseases of the respiratory system and accident. In the case of alcoholism, the excess is 169 per cent., in that of diseases of the liver, 107 per cent., and in that of suicide, 64 per cent.

Table 56 shows how the mortality of the years 1890-92 compares with that ascertained from the census returns and register of death in former years.

I have now dealt with the four classes of occupations indicated in the early part of this Paper; and I trust the information I have given, may be of some use to actuaries in estimating the proper premiums to be charged to persons in the different occupations. I have not, however, been able to make use of all the available material. I refer especially to the information contained in the annual reports of the Chief Inspector of Factories and Workshops, and other publications connected with the Factory Acts. Under the Act of 1891, the Secretary of State has authority to certify particular industries and processes, as dangerous or injurious to health, and to make special rules for their conduct. Processes connected with a number of industries have been already certified as dangerous to health; and departmental committees have been at work, examining into the conditions under which various trades are carried on, and suggesting special rules in each case. A list of Processes certified by the Secretary of State as dangerous or injurious to health, kindly furnished to me by the Chief Inspector of Factories, is given in Appendix B.

I trust that what I have put before the Society to-night, may serve the additional purpose of leading some of the younger members to devote their attention to the subject of class mortality, and to do something to make the latest information on the subject, available for use in the practical conduct of life assurance business.

LIST OF BOOKS AND PAPERS REFERRED TO.

Census of Great Britain, 1851, Population Tables II. Vol. I.

Census of England and Wales, 1861, Population Tables Vol. II.

Census of England and Wales, for the year 1871, General Report, Vol. IV.

Census of England and Wales, 1891, Vol. IV., General Report.

14th and 58th Annual Reports of the Registrar-General of Births, Deaths, and Marriages in England.

Supplements to the 25th, 35th, and 45th Annual Reports of the Registrar-General.

Supplement to the 55th Annual Report of the Registrar-General, Part II.

Abstracts of the Returns made to the Board of Trade, of Shipping Casualties, etc., for the statistical years 1885-86 to 1895-96 inclusive.

Annual Statement of the Navigation and Shipping of the United Kingdom, for the years 1886 to 1895 inclusive.

General Reports to the Board of Trade, upon the Accidents that have occurred on the Railways of the United Kingdom, during the years 1892-95 inclusive.

Returns of Accidents and Casualties, as reported to the Board of Trade by the several Railway Companies in the United Kingdom, during the year ending 31st December 1896.

Mines and Quarries—General Report and Statistics for 1897, Part II., Labour.

Third Interim Report of the Departmental Committee appointed to inquire into and report upon certain Miscellaneous Dangerous Trades, 1898.

Annual Report of the Chief Inspector of Factories and Workshops, for the year 1896.

Report and Tables by the Actuary of the National Debt Office, [Mr. A. G. Finlaison], on the subject of Sickness and Mortality among the Members of Friendly Societies, to 31st December 1850.

On the Rates of Fatal Accidents in various Occupations. By W. J. H. Whittall, F.I.A. (J.I.A., XXIII., 188).

APPENDIX A.

General Classification of Occupations.

In classifying the occupations given in Dr. Tatham's Table I., according to the nature of the occupation, I have followed, as closely as possible, the classification made by Mr. A. G. Finlaison, as given in his report of 1853 (see pp. 20-25); except that I have included seamen and miners in the general classification, instead of making them independent classes. The occupations included under each head are as follows:—

I. Light labour without exposure to the weather.

Clergyman, Priest, Minister.
Barrister, Solicitor.
Law Clerk.
Physician, Surgeon, General Practitioner.
Schoolmaster, Teacher.
Artist, Engraver, Sculptor, Architect.
Musician, Music Master.
Domestic Indoor Servant.
Commercial Clerk, Insurance Service.
Railway Official, Clerk.
Maltster.
Innkeeper, Publican; Spirit, Wine, Beer Dealer.
Inn, Hotel—Servant.
Publisher, Bookseller, Stationer, etc.
Chemist, Druggist.
Tobacconist, etc.
Milkseller, Cheesemonger, etc.
Fishmonger, Poulterer.
Fruiterer, Greengrocer.
Grocer, etc.
Draper, Manchester Warehouseman.
Coal Merchant, etc.
Ironmonger.
General Shopkeeper.
Bookbinder.
Printer.
Watch, Clock, Philosoph. Inst. Maker, Jeweller, etc.
Saddler, Harness Maker.
Butcher.
Baker, Confectioner.
Hatter.
Tailor.
Shoemaker.
Hairdresser.
Tallow, Soap, Glue, Manure, etc., Manufacture.
Tanner, Fellmonger.
Currier, etc.
Carpenter, Joiner.
Cabinet Maker, etc.
Wood Turner, Cooper, etc.
Wool, Worsted Manufacture.
Silk, Satin, Crape, etc., Manufacture.
Cotton, Flax, Linen Manufacture.
Lace Manufacture.

Wool, Silk, Cotton. etc.—Dyer, Printer, etc.
Carpet, Rug Manufacture.
Hosiery Manufacture.
Paper Manufacture
Potter, Earthenware, etc., Manufacturer.
Engine Driver, Stoker, Fireman, (not railway, marine no agricultural).
Artisans, Mechanic (undefined).
Factory Labourer (undefined).

II. LIGHT LABOUR WITH EXPOSURE TO THE WEATHER.

Commercial Traveller.
Railway Engine Driver, Stoker, etc.
Railway Guard, Porter, Pointsman.
Coach and Cab Service, Groom, etc.
Messenger, Porter, etc. (not Railway, nor Government).
Farmer, Grazier, Farmer's Son, etc.
Plasterer, Whitewasher, Paperhanger.
Rope, Twine, Cord—Maker.
Chimney Sweep, Soot Merchant.

III. HEAVY LABOUR WITHOUT EXPOSURE TO THE WEATHER.

Brewer.
Corn Miller.
Engine, Machine, Boiler—Maker, Fitter ; Millwright.
Tool, Scissors, File, Saw, Needle—Maker.
Gunsmith.
Locksmith, Bellhanger, Gasfitter.
Blacksmith, Whitesmith.
Nail, Anchor, Chain, and other Iron and Steel Manufactures.
Copper, Tin, Zinc, Lead, Brass, etc.—Worker and Dealer.
Sawyer.
Coach, Carriage—Maker.
Wheelwright.
Shipwright, etc. (Wood and Iron).
Manufacturing Chemist.
Glass Manufacture.
Coal Miner.
Ironstone Miner.
Copper Miner.
Tin Miner.
Lead Miner.
Mine Service.

IV. HEAVY LABOUR WITH EXPOSURE TO THE WEATHER.

Carman, Carrier, etc.
Bargeman, Lighterman, Waterman.
Seaman, etc., Merchant Service.
Dock Labourer, Wharf Labourer.
Farm Labourer, Farm Servant.
Gardener, Nurseryman, Seedsman.
Fisherman.
Bricklayer, Mason, Builder.
Slater, Tiler.

Stone, Slate—Quarrier.
Coal Heaver.
Gas-Works Service.
Railway Platelayer, Railway, Road, Clay, Sand, etc.—Labourer.
Brick, Tile—Maker, Burner.

I have omitted the following classes as too indefinite to admit of satisfactory classification, namely, 'General Labourer,' 'Other Occupied Males,' and 'Costermonger, Hawker, etc.' (see the observations as to the last-mentioned class, on page xxiii of the Supplement to the 45th report of the Registrar-General). I have also excluded the class entitled 'Plumber, Painter, Glazier,' as it cannot be suitably placed under any of Mr. Finlaison's four headings.

The following table gives the figures from which the percentages in Table 1 are calculated :—

TABLE *showing mean annual Mortality of Males in different Classes of Occupations,* 1890-91-92, *at successive periods of life.*

Classes of Occupations.	Years of life.				Deaths.			
	25-35.	35-45.	45-55.	55-56.	25-35.	35-45.	44-45.	55-65.
I. Light labour without exposure . .	1,989,246	1,440,558	1,025,004	598,449	14,489	17,753	21,174	22,893
II. Light labour with exposure	555,675	446,790	327,000	215,511	3,588	5,051	5,842	6,822
III. Heavy labour without exposure . .	1,108,829	837,441	567,891	290,055	7,705	10,150	12,898	13,041
IV. Heavy labour with exposure	1,217,370	988,020	768,447	527,790	8,925	12,169	14,771	17,314
Excluded . .	1,280,910	1,001,421	737,751	440,271	10,114	13,490	16,094	16,401
All occupied males	6,147,030	4,714,230	3,426,093	2,072,076	44,821	58,613	70,779	75,971

APPENDIX B.

List of Processes certified by the Secretary of State under the Factory Act, 1891, section 8, to be dangerous or injurious to health.

Processes in	Date of Certificate.
The Manufacture of White Lead. The Manufacture of Paints, Colours, and in the extraction of Arsenic. Enamelling of Iron plates.	9 May, 1892.
The Manufacture of Lucifer Matches, except such as are made with red or amorphous phosphorus.	2 June, 1892.

APPENDIX B—*Continued.*

Processes in	Date of Certificate.
The Manufacture of Earthenware (and see Order of 7 May 1898). The Manufacture of Explosives in which di-nitro-benzole is used. Chemical Works.	24 December, 1892.
The Manufacture of Red, Orange, or Yellow Lead. Lead-Smelting. The Tinning and Enamelling of Iron Hollow Ware. Electric Accumulator Works.	2 January, 1894.
Flax Mills and Linen Factories	3 January, 1894.
The Tinning and Enamelling of Metal Hollow Ware and Cooking-Utensils	19 June, 1894.
Processes in which Yellow Chromate of Lead is used, or in which goods dyed with it undergo the process of bundling or noddling, winding, reeling, weaving, or any other treatment .	9 April, 1895.
The Mixing and Casting of Brass, gun metal, bell metal, white metal, delta metal, phosphor bronze, and manilla mixture	1 January, 1896.
The Sorting of Wool, goat hair or camel hair, and the processes incidental thereto . .	23 July, 1896.
The Bottling of Aerated Waters and the processes incidental thereto, including the examining and labelling of the bottles	11 September, 1896.
Vulcanising India-rubber by means of bisulphide of carbon and the processes incidental thereto	1 December, 1896.
Sorting Foreign Hides and skins and dry East Indian hides and skins, and the processes incidental thereto	2 April, 1898.
Manufacture and Decoration of Earthenware and China	7 May, 1898.
The Dusting of Colours on adhesive surfaces for the purpose of making transfers for use in the manufacture or decoration of earthenware and china	3 August, 1898.
The Glazing of Bricks with the use of lead . .	17 December, 1898.

Some Questions arising in the Valuation of Special Class Policies

BY

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Some Questions arising in the Valuation of Special Class Policies.

(*Read before the Actuarial Society of Edinburgh, 6th April* 1899.)

THE subject of Valuation is one of such superlative importance to the actuary that possibly even a merely repetitional paper may not be wholly without interest. Two of the most important contributions to the practical side of the science have appeared but recently in the *Journal of the Institute of Actuaries*—Mr. Chatham's paper on the books to be used in scheduling the particulars of the risks of a Life Assurance Company (*J.I.A.*, xxxii. 393), and that by Mr. Lidstone on the Valuation of Endowment Assurances in groups (*J.I.A.*, xxxiv. 61). What follows is in great measure an attempt, on the basis of these papers, to present forms for valuation purposes adapted to an Office declaring quinquennial reversionary bonuses on the Sum Assured or on the Sum Assured and Existing Bonuses—furnishing the particulars essential to an annual investigation, while at the same time providing for a quinquennial return to the Board of Trade.

Before the valuation formulæ for any particular Office can be definitely fixed upon, some preliminary inquiry is necessary as to the distribution of the premiums throughout the year. In ordinary circumstances it will probably be found that the next premium falls due on the average about eight months after the date of the valuation. The annuity by which the whole life premiums are valued is $\frac{2}{3}|a_x$ or $\frac{1}{3} + a_x$. In the case of Endowment Assurance and Limited Payment Policies, however, the annuity is $\frac{2}{3}|a_{x:\overline{n}|}$ or $\frac{a_{x:\overline{n}|} + 2a_{x:\overline{n}|}}{3}$; so that tables of specially prepared annuity-values require to be computed before the investigation can be carried through. This objection may be obviated by dividing each group into two sections according as the next premium is payable within or beyond six months of the date of valuation. The premiums in the first section are multiplied by the annuity-due, and in the second section by the ordinary annuity. It is tacitly assumed that this method will yield a correct result by making an automatic adjustment of the disposition of the premium income, but unless there be a regular—not

necessarily uniform, but, so to speak, symmetrical—distribution, it cannot exhibit strictly accurate results. Suppose, for instance, the valuation to be made as at 31st December, twice as much business being done in the second half of the year as in the first half; if the average renewal for the first six months falls on 1st May (and these are substantially the results of an actual investigation), the Nearest Renewal Method will only give an absolutely correct result if 1st November is the average renewal date for the second six months of the year. Thus if P represent the January-June premiums, and $2P$ those for July-December, the valuation formula, on the foregoing supposition as to incidence of income, would be $(P)\cdot{}_{\frac{4}{12}|}\mathbf{a}_{x:\overline{n}|} + (2P)\cdot{}_{t|}\mathbf{a}_{x:\overline{n}|}$, which is only equal to $(P)\cdot\mathbf{a}_{x:\overline{n}|} + (2P)\cdot a_{x:\overline{n}|}$ if $t = \frac{10}{12}$. Some preparatory examination in every case would therefore seem to be advisable.

These remarks are based on the assumption that the age at valuation for the group has already been fixed, so that the only question arising at present is with regard to the average date when the next premium falls due.

It has been contended that when the valuation age is based on the age nearest birthday, the net premiums valued should be those for nearest age also; but, on the other hand, the net premiums for the age next birthday correspond to the office premiums actually receivable. All benefit arising from taking next birthday premiums and nearest ages at valuation is exhausted at the first investigation following entry.

Half-Yearly and Quarterly Policies.

The addition to the yearly net premium to permit of its being paid at more frequent intervals is required (1) to cover the risk of losing part of the premium in the year of death, and (2) to make good the loss of interest on that portion of the premium not paid at the beginning of the year. Taking Endowment Assurances as an instance, this is clearly seen in the well-known formula:—

$$\pi^{(m)}_{x:\overline{r}|} = \pi_{x:\overline{r}|} + \pi^{1}_{x:\overline{r}|}\left(\frac{m-1}{2m}\cdot\pi^{(m)}_{x:\overline{r}|}\right) + d\left(\frac{m-1}{2m}\cdot\pi^{(m)}_{x:\overline{r}|}\right)$$

Policy-holders with m^thly premiums are therefore paying three distinct charges, and when such policies come to be valued the component parts may still be kept separate. Accordingly, guided by the above formula, we may say that the true value of an m^thly policy is equal to

(1) the value at the same period of a corresponding yearly policy (less that proportion of the yearly premium taken credit for but not yet received)

+(2) the value of a corresponding annual temporary policy for an insurance of $\frac{m-1}{2m}\cdot\pi^{(m)}_{x:\overline{r}|}$ (less that proportion of the yearly premium taken credit for but not yet received)

+(3) the proportion to date of next renewal of the interest of $d\left(\frac{m-1}{2m} \cdot \pi^{(m)}_{x:\overline{r}|}\right)$

At first sight it may seem that the outstanding proportion of the yearly premiums ought to be discounted with mortality and interest, but a little consideration will show that such outstanding premiums are certain to be received owing to the insurance under section (2), and received moreover with interest seeing that the insurance is for $\frac{m-1}{2m} \cdot \pi^{(m)}_{x:\overline{r}|}$ which includes provision against loss of interest.

Translating the above into the notation of Mr. M'Lauchlan's paper (*Transactions*, vol. ii. 378), we have

$$
\begin{aligned}
{}_{n+t}V^{(m)}_{x:\overline{r}|} = (1) \quad & \left\{ {}_{n+t}V_{x:\overline{r}|} - \pi_{x:\overline{r}|}\left(1 - \frac{k+1}{m}\right)\right\} \\
+ (2) \quad & \left\{ {}_{n+t}V^{1}_{x:\overline{r}|} - \pi^{1}_{x:\overline{r}|}\left(1 - \frac{k+1}{m}\right)\right\} \cdot \frac{m-1}{2m} \cdot \pi^{(m)}_{x:\overline{r}|} \\
+ (3) \quad & \left(\frac{1}{m} - s\right) d \cdot \frac{m-1}{2m} \cdot \pi^{(m)}_{x:\overline{r}|}
\end{aligned}
$$

which is precisely the same formula as Mr. M'Lauchlan's, although deduced in a different way.

If the m^{thly} payments are not true premiums but merely instalments, the insurance under section (2) will disappear.

In practice, the additions under sections (2) and (3) are usually ignored, the half-yearly and quarterly policies being treated exactly as if they were annual ones, under deduction, however, of the outstanding proportion of the yearly premium. It is curious to notice that in the case of quarterly policies under a Nearest Renewal Valuation, the yearly premiums are in effect multiplied by $1+a$, $1\frac{1}{4}+a$, $\frac{1}{2}+a$, or $\frac{3}{4}+a$, according as the policy was taken out in the 1st, 2nd, 3rd, or 4th quarter of the year.

Similar reasoning is applicable to any other class of policy.

Relation of the Valuation Totals to the Ordinary Accounts and Records.

It is essential to be able to prove that the Valuation Totals are in accordance with the ordinary Office records. The aftermentioned books are intimately connected with the Valuation Schedules.

The *Claim Register* contains a record of the Sums Assured, Bonuses, and Office Premiums, under those policies becoming claims in any year; the *Cancel Book* contains similar particulars regarding policies terminating otherwise than by death or maturity; and the *Alteration and Deduction Book* registers alterations in premiums under existing policies. A summary of the entries in the above books may be

incorporated in the following statement, which can conveniently be inserted in the Policy Register at the end of each year :—

	Number of Policies.	Sum Assured.	Year's Premiums (extra in red).
Summation of New Life Business for year (per Policy Register), . .			
Add—			
Insurances in force at end of previous year (from last year's statement), .			
Additions to year's premiums (per Alteration Book), ...			
Subtract—			
Cancels (per Cancel Book), . .			
Claims (per Claim Register), . .			
Deductions from year's premiums—including single payments and premiums under policies paid up during year (per Alteration and Deduction Book), ...			
Leaving Total Assurances in force at end of year, and corresponding premiums for reconcilement with Renewal Premium Book, . . .			

The figures in the Valuation Summary must correspond with this statement. The accountant should be able to effect a reconcilement with the premiums in the Revenue Account somewhat as follows :—

Year's premiums under total ass'ces in force at end of financial year (per Policy Register), ...		£
Add—		
Single Payments received and premiums under policies paid up during year, ...		
Premiums received for the year under terminated policies, .		
Extra premiums (less rebates), ...		
Miscellaneous receipts, ...		
Fines, ...		
		£
Subtract—		
Unpaid portion of year's premium in the case of new half-yearly and quarterly policies (the valuation schedules could be used to obtain this information), .	£	
Any miscellaneous deductions, . . .		
	£	£
		£

The result should agree with the General Ledger Balance of

the Premiums Account. This confirmation that the whole premium revenue has been received is desirable, apart altogether from the valuation.

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General Description of Schedules.

(*For forms see Appendix.*)

The left-hand page of the folio is reserved for policies issued, and the emerged or altered policies are entered on the opposite side—each year's cancels, claims, and alterations being entered together. The figures to be written off are consequently close at hand. The use of different coloured inks will serve to distinguish the several classes of entry and facilitate the necessary balances. At date of writing-up the schedules, the totals of the policies issued must agree with the respective figures in the statement appended to the Policy Register. Thereafter new sums assured and premiums written on must tally with the corresponding figures in the Policy Register. The Sums Assured, Premiums, and Bonuses written off must conform to the appropriate totals of the various terminational registers—the Claim Book, the Cancel Book, and the Bonus Surrender Book. A check upon the alterations of the office premiums under existing policies is established with the Alteration and Deduction Book.

The summations on the left-hand page are not affected by these entries until the end of the year, when the net totals of the opposite page are carried across, bringing out the figures for the business in force at the close of the year. The summary of these results must balance with the statement in the Policy Register.

The schedules will last for as many valuations as there are bonus columns, but in any case it will probably be considered advisable to rewrite the sheets every ten or fifteen years.

The New Bonus Deduction column (see *Post Mag.*, 28th March 1896) is introduced in order to simplify the calculation of the amount and value of new bonus at the rate of one per cent. per annum, from which the actual rate of bonus available for distribution may be found when the divisible surplus has been ascertained. Against those new policies which are not entitled to five full years' bonus at date of valuation, there is inserted in this column the difference between five per cent. on the sum assured and the bonus (at one per cent. per annum) to which the policy will be entitled at the close of the quinquennium. At the valuation the amount of new bonus at one per cent. per annum for the policies of any group is found by taking five per cent. of the total sum assured, or sum assured and existing bonuses,

according to the bonus system of the office, and deducting therefrom the total of the new bonus deduction column.

The premiums received as at 31st December 1900 are inserted in the "Total Premiums Received" column, and this total is carried on from year to year by the addition of the year's premiums under the policies in force at the end of each year thereafter, less the outstanding proportion relating to the new half-yearly and quarterly policies. The entry on the "written-off" side, in the case of policies terminating after 31st December 1900, consists of the total premiums received as at the 31st December immediately preceding the date of termination.

Mr. Ryan has shown (*J.I.A.*, xxiv. 19) that the theoretical reserve under whole life policies, rated up in respect of extra risk uniform at all ages by the addition to the premium of a constant percentage on the sum assured, is smaller than the reserve under corresponding normal policies in all cases where the assurance is without profits, and in most cases, but to a smaller extent, when reversionary bonuses attach to the policy. This was confirmed and extended to Endowment Assurances in a paper by Messrs. White and Whittall (*J.I.A.*, xxiv. 385). Notwithstanding this, however, it is usual to treat a life subject to extra in respect of occupation or climate risk as if the extra premiums were just sufficient to cover the extra mortality from year to year, and to value the policies at the true ages, an additional reserve being made of the proportion of extra premium to date of next renewal. Accordingly, when the lives are not dealt with at the rated-up age, the extra premiums are inserted in red ink. The extra premiums annually receivable are also required for submission to the Board of Trade.

The year of maturity is found by adding the difference between the ages at maturity and entry to the year of entry.

Endowment Assurances. Each year of maturity is divided into two parts, according as the nearest renewal succeeds or precedes the valuation date, the words "January-June" or "July-December" being inserted under the year of maturity according to the section of the group. The assumed maturity age, "M," is found by subtracting the Office year of birth from the year of maturity; for July-December policies Z^M is inserted from Lidstone's Table; for January-June policies the factor to be used is Z^{M-1}.

The totals of the January-June policies of any group are added to the summations of the July-December policies of the preceding group. The combined Z column is divided by the number of thousands in the combined sums assured, and by entering Lidstone's Table inversely the mean maturity age is found. Subtracting from this the difference (n) between the year of maturity of the July-December section and the year of valuation,

we get the mean valuation age of the group. If x be the resulting average age, the total sums assured are multiplied by $A_{x:\overline{n}|}$, and the total premiums by $a_{x:\overline{n-1}|}$, the value of the premiums being then increased by the amount of the premium column under the January-June section. The value of the premiums falls to be further increased by the outstanding premiums in respect of the half-yearly and quarterly policies. The net half-yearly premiums outstanding may be ascertained with sufficient exactness by reducing the outstanding office premium column in the ratio of the net premiums to the office premiums of the group.

The average age at valuation ought to be found separately for the sums assured and premiums, and in estimating the mean age for the sums assured, the existing reversionary bonuses should be taken into account. There is this disadvantage in including the bonuses in the reckoning, that the value of Z^M must be recalculated after every distribution. Probably, therefore, it may be considered expedient to neglect the existing bonuses, and in this event it is better not to make a separate calculation for the premiums. The reason for this is that the policies with the largest reversionary bonuses of the group have not only the greatest present age, but have also been longest on the books, and are subject to the smallest premiums; if, therefore, both reversionary bonuses and premiums be left out of account, the average age will tend to be too low for the sums assured and too high for the premiums, and the resulting errors will partly counterbalance one another. In the case of non-profit policies, however, there is no such counteractive effect, and a separate valuation age should be found for the premiums. Strictly speaking, it is the net premium which should be taken into calculation, but if—as is not unusual—the valuation be made tentatively at two rates of interest, a double process would be involved. The office premiums will not differ much relatively, and by their use this difficulty is overcome. But this argument may be carried a little further, for if the Office premium were rigidly employed, a distinct multiplication for Z^M would be necessary in almost every case, and even if the Office premium were taken to the nearest pound, the requisite table of Z^M would be very extensive. All trouble on this score can be avoided by taking the premium to the nearest £2, 10s., up to say £25, and to the nearest £5 thereafter. The extent of table required is little more than double that given by Mr. Lidstone. No change in the value of Z^M will in general be required when a policy is changed from yearly to half-yearly, or *vice versa*.

To obtain the divisor of Z^M it may be considered necessary to find the summation of a similar proportion of the Office premiums, and with very little practice this can be done quite readily from

the Office Premium column. The simplest plan is to sur number of *fives* in the column; for instance:—

If the Office premiums were			the mental process wou	
£12 2 0	. .	. .	.	$2\frac{1}{2}$
27 7 6	. .	. .	and 5 =	$7\frac{1}{2}$
12 12 6	. .	. .	and $2\frac{1}{2}$ =	10
4 12 9	. .	. .	and 1 =	11
4 0 0	. .	. .	and 1 =	12
£60 14 9				

and the divisor to find the average age would be $12 \times 5 = 60$.

The following figures, relating to two groups of policies absolutely at random, show the remarkable degree of acc which may be expected by the use of this method:—

Number of Policies.	Approximate Summation of Premiums.	Summation of Z^M (approximate calculation).	Exact Summation of Premiums.	Summatio (exact ca tion)
42	1600	120787	1581·475	11873
58	2175	301299	2182·137	30214
100	3775	422086	3763·612	42088

In the first group the average value of Z^M by the approxi method comes out as 754·9, while the exact calculation 750·8. The average maturity age is 51·9 both by the approxi and by the exact method. In the second group, the correspo values of Z^M are 1385·3 and 1384·6, with an average mat age of 58·6 according to both methods. Taking the two g together, the values of Z^M are 1118·1 and 1118·3 by the app mate and exact methods respectively, and both methods brin an average maturity age of 56·2. Further calculations v have been made exhibit the same uniformity in the results o two methods.

If the exact summation of the premiums be combined wit approximate calculation of Z^M, the respective average mat ages come out as 52·1, 58·5, and 56·2. If these results be sidered sufficiently accurate, the summation of the Office Pre to the nearest £2, 10s. or £5 may perhaps be dispensed with

For this class two series of groups are employed. The po are arranged according to Office Year of Birth in order to

Limited Payment Policies. the value of the Sums Assured. In valuing future premiums the policies are grouped acco to the year in which the premium ceases to be payable, an average age is found from the Office Premium in the m already described.

Adjustment for future expenses and profits.—It is gen

admitted that, so far as limited payment and paid-up policies are concerned, the principles of a strictly net premium valuation must be departed from in order to make provision for expenses and profits after the premiums have been paid up. To this end it is not unusual to take credit for the Office Premium actually receivable, under deduction of commission, and to reserve in addition the value of the loading under a whole life policy for a similar amount effected at the same entry age, less the commission contained therein. In order to employ this method, it would merely be necessary to insert additional columns headed "Age at Entry," and "Whole Life Loading" in the Sum Assured Sheet.

Another plan may however be suggested. Dr. Sprague has pointed out that if equity is to be preserved under the Simple or the Compound Reversionary Bonus System, the bonus loadings contained in the premiums must not materially differ from those obtained by precise calculation. Now, Mr. Andras has shown (*J.I.A.*, xxxii. 348) that under these systems the whole life bonus loadings are practically the same whatever table of mortality is used as the basis of calculation, and for this reason—that in the mortality tables giving a light rate of mortality the bonuses continue to accrue for many years, which is a set-off against the increase of premium arising from the use of tables showing a high rate of mortality. The same argument will apply in some degree to the bonus loadings for different ages by the same mortality table, and when it is kept in view that the age at entry under limited payment policies does not in general vary greatly, it would appear that the basis of the reserve for future profits may, without any great loss of accuracy, be made a constant ratio to the sum assured. The constant may be taken rather less than the average whole life bonus loading on account of the larger interest profit on Limited Payment Policies. Furthermore, the expenses, apart from commission and the initial outlay, seem to depend almost entirely upon the number of policies. In theory, therefore, it might be thought desirable to base the correction partly upon the sums assured and partly upon the number of policies. In practice it may be considered sufficient to employ the sum assured as the basis for the adjustment. At any rate, if commission be left out of account, the expenses are connected as directly with the sums assured as with the premiums. Probably, therefore, a satisfactory result would be obtained by taking credit for the Office Premiums payable (less commission), and reserving in addition a constant percentage on the sum assured of each group multiplied by the appropriate annuity—$(\frac{2}{3} + a_x)$.

The valuation rate of interest is commonly taken lower than that actually realised, in order to maintain the bonus rate, and if the same reduced rate is employed in the valuation of the

Non-profit Limited Payment Policies, it seems unnecessary in their case to make any further provision for future expenses.

At an interperiodic investigation an approximate valuation is all that is wanted, and an abridged procedure may be suggested. Use one series of groups only—that according to year of birth—and base the reserve upon the equivalent paid-up policy for that proportion of the sum assured which the number of premiums paid bears to the total number payable. A column would be required in the valuation schedule to show the portion of the sum assured secured by each year's payment, and the total would be carried year by year into a second column, giving the amount in reversion for which provision has to be made. If a rate of interest one quarter per cent. below the ordinary valuation rate be employed, the result brought out will closely approach a net premium valuation at the ordinary rate.

Ascending Scale Policies.

When the lower premium is only slightly higher than the corresponding short term rate, this class is often valued during the currency of the low initial premium as if the policies were effected by short term premium, and there is reserved in addition the accumulated difference between the premium payable and the short term rate. This provides for the option of continuing the policy when the low term has expired. Provided the higher premium does not differ greatly from the ordinary whole life rate at the increased age, sufficiently accurate results will probably be obtained, if the valuation is based on the H^M Table, by founding the reserve for this class upon the H^M and $H^{M(5)}$ Tables whenever the increased premium becomes payable.

Other Special Classes.

(For form of schedule see appendix.)

Policies in the other special classes are not usually effected in sufficient numbers to warrant a group valuation, but full particulars are inserted so as to admit of an individual valuation being made, space being also provided for the valuation results.

Adjustment for Early Payment of Claims.

An adjustment has to be made on the net reserve brought out by the ordinary formulas in respect of the sum assured being payable less than six months after death. The date of payment of the sum assured being altered, the value of the reversion is altered, and as a consequence the net premium is affected also, seeing that at the outset the value of the premiums should not be less than the value of the sum assured. If the claims are payable immediately on proof of death, it is usual to increase the ordinary reserve under whole life and limited payment policies by from four to six months' interest at the valuation rate, which gives the same result as if the modified reversion and net premium had been employed.

This simple adjustment is not applicable, however, to the case of endowment assurances, because the endowment portion is not affected although the time be altered at which the insurance may become payable in event of death. To arrive at accurate results it would be necessary to use the appropriate valuation factors, but to calculate these for all the terms and ages would entail a considerable amount of labour, and it behoves us to see if a simple approximate process cannot be adopted.

The correct reserve for a policy effected within the first six months of a year at age $x-m$, with present age x, and maturing at age $x+n$, is

$$\frac{(M_x-M_{x+n})(1+i)^{\frac{1}{2}}+D_{x+n}}{D_x}-\frac{(M_{x-m}-M_{x+n})(1+i)^{\frac{1}{2}}+D_{x+n}}{N_{x-m-1}-N_{x+n-1}}\cdot\frac{N_{x-1}-N_{x+n-1}}{D_x}$$

The portion of this which is unaffected by immediate payment is

$$\frac{D_{x+n}}{D_x}\left\{1-\frac{N_{x-1}-N_{x+n-1}}{N_{x-m-1}-N_{x+n-1}}\right\}={}_nE_x\cdot\frac{a_{x-m:\overline{m}|}}{a_{x-m:\overline{m+n}|}}$$

The balance is subject to correction.

For a similar policy in the July-December section of the group, the expression for the adjusted reserve is

$$\frac{(M_x-M_{x+n})(1+i)^{\frac{1}{2}}+D_{x+n}}{D_x}-\frac{(M_{x-m}-M_{x+n})(1+i)^{\frac{1}{2}}+D_{x+n}}{N_{x-m-1}-N_{x+n-1}}\cdot\frac{N_x-N_{x+n-1}}{D_x}$$

and the unaffected portion is

$$\frac{D_{x+n}}{D_x}\left\{1-\frac{N_x-N_{x+n-1}}{N_{x-m-1}-N_{x+n-1}}\right\}={}_nE_x\cdot\frac{a_{x-m:\overline{m+1}|}}{a_{x-m:\overline{m+n}|}}$$

In a group of policies the average maturity age and the average present age are both known, so that ${}_nE_x$ can be found from a table of temporary annuities by deducting $a_{x:\overline{n-1}|}$ from $a_{x:\overline{n}|}$. If the total net premiums be divided by the total sums assured, we get the average rate of premium for an assurance payable at age $x+n$ or previous death; and if a complete table of net premiums for endowment assurances maturing at age $x+n$ be available, the average age at entry can at once be found. If these premiums be not tabulated, Conversion Tables may be entered inversely with the average net premium, when the average annuity ceasing at age $x+n-1$ will be obtained, and the average age at entry can then be found by inspection from the temporary annuity values.

If the total sum assured in the January-June section of the group multiplied by ${}_nE_x\cdot\frac{a_{x-m:\overline{m}|}}{a_{x-m:\overline{m+n}|}}$ be combined with the total sum assured in the July-December section multiplied by ${}_nE_x\cdot\frac{a_{x-m:\overline{m+1}|}}{a_{x-m:\overline{m+n}|}}$, and deducted from the reserve value found in the ordinary way, the remainder multiplied by $\{(1+i)^{\frac{1}{2}}-1\}$, or $\frac{i}{2}$ in

practice, will form the addition to the ordinary reserve so as to provide for immediate payment of claims.

It is scarcely necessary to go through this process for every group; the ratio of increase in the ordinary reserve is very small indeed when the unexpired term is short, and becomes gradually greater with the extension of the endowment term. The values of the ratio may be found for the central of, say, quinquennial groups, and the reserves for the adjacent groups increased in the same proportion.

Maintenance of Bonus Rate.

Reference has already been made to the fact that under the Simple or the Compound Reversionary Bonus system, the Office Premiums should have been originally computed with the method of distribution in view, for otherwise there will most probably be unfairness as between entrants at different ages and in different classes. But the method of distribution must also be borne in mind in determining the valuation basis. The cash value of a simple or compound reversionary bonus tends to increase with the age, while the bonus loading contained in a premium does not vary throughout the duration of the contract. If, therefore, the valuation be made at the true rate of interest and by a true table of mortality, the same cash surplus will be available for distribution at each successive valuation, and consequently the rate of reversionary bonus will become less and less the longer a policy continues in force. In order to maintain the same rate of bonus from valuation to valuation, only a proportion of the surplus must be distributed, and the remainder kept in hand and accumulated as bonus reserve. This may be accomplished by making the valuation according to the formula $A' - \pi' \cdot \mathbf{a}$, where A' and π' are the pure single and annual premiums for an assurance of one, increasing by the rate of bonus which it is anticipated the policies will receive. The method adopted by most Offices, however, to keep up the rate of bonus, is to employ a lower rate of interest in the valuation than that actually realised. This has the desired effect of bringing out a smaller apparent surplus in the early quinquenniums and spreading the profit more over the later years, for the longer a policy remains in force the larger is the reserve upon which excess interest is earned. It has been ascertained by several actuaries that a margin of $\frac{1}{2}$ to $\frac{3}{4}$ per cent. above the valuation rate of interest is required to maintain a constant reversionary bonus of 30s. per cent. per annum, while for a compound reversionary bonus an excess rate of about one per cent. is necessary. These conclusions are based for the most part upon investigations confined to whole life policies, and the original aim of the follow-

ing inquiry was to ascertain to what extent they may be relied upon in the case of Endowment Assurances, by comparing the specific additional reserve to maintain the bonus rate under a true valuation with the difference between the reserves brought out by valuing at the reduced and at the true rates of interest. The H^M table of mortality has been employed, any profit arising from the favourable mortality under Endowment Assurances being assumed to counterbalance the effect of the heavy expenses incurred in placing the policy on the books. On account of this excessive initial outlay, the bonus does not usually vest in practice until the policy has been a year or two in force. The true rate of interest was taken at 4 per cent., not that this was considered the rate likely to be realised in the future, but that by employing such a rate the figures for the respective interest margins of $\frac{1}{2}$, $\frac{3}{4}$, and 1 per cent. could be easily obtained. Possibly $3\frac{3}{4}$ per cent. would be a nearer approach to the true rate, but the 4 per cent. figures may perhaps serve equally well for the object in view.

In a paper on the Bonuses under Endowment Assurance Policies (*J.I.A.*, xxviii. 257), Mr. Sunderland showed that the profit on policies having originally the same period to run is practically the same whatever the age at entry may be, and it may be said with reasonable accuracy that the values of the bonuses are not affected by the age at entry, but depend only on the endowment term. The calculations are accordingly restricted to policies effected at age 30, payable at 50, 55, 60, and 65. The policies are supposed to be taken out at the commencement of a quinquennium, which is the usual assumption in making such investigations. It is further hypothesized that interim bonuses are allotted, so that those policies which emerge within a valuation period absorb their own share of the profits of the quinquennium.

The present values of bonuses on Endowment Assurances can conveniently be found from the values of Whole Life bonuses for the same age at entry. If B and B' represent respectively the values of a simple and a compound reversionary bonus at the rate of r per annum, then

$$B_{x:\overline{n}|} = B_x + \frac{D_{x+n}}{D_x}\left\{n\,r\,(1-A_{x+n}) - B_{x+n}\right\} \text{ and}$$

$$B'_{x:\overline{n}|} = B'_x + \frac{D_{x+n}}{D_x}\left[\left\{(1+5r)^{\frac{n}{5}}-1\right\}(1-A_{x+n}) - (1+5r)^{\frac{n}{5}}\,B'_{x+n}\right]$$

If the values of the Whole Life bonuses have been already calculated, a considerable saving of labour is effected by these formulas, especially in the case of a compound bonus policy. The value of $(1+5r)^{\frac{n}{5}}$ may be found by reference to Interest Tables.

In the present instance, however, the values of the Whole Life bonuses were not available. The Endowment Assurance Bonus values may be calculated directly from the mortality table by means of the formulas :—

$$B_{x:\overline{n}|} = r \cdot \frac{R_x - R_{x+n} - n \cdot M_{x+n} + n \cdot D_{x+n}}{D_x}$$

$$B'_{x:\overline{n}|} = \frac{1}{D_x} \cdot \left\{ \begin{array}{l} r(R_x - R_{x+5}) + r(1+5r)(R_{x+5} - R_{x+10}) + r(1+5r)^2 (R_{x+10} - R_{x+15}) \\ + \cdots + r(1+5r)^{\frac{n-5}{5}} (R_{x+n-5} - R_{x+n}) + \{(1+5r)^{\frac{n}{5}} - 1\}(D_{x+n} - M_{x+n}) \end{array} \right.$$

The addition to the net annual premium by way of bonus loading, which may be represented by $b_{x:\overline{n}|}$ and $b'_{x:\overline{n}|}$ for a simple and a compound bonus respectively, is computed by dividing the expression for the present value of the bonus by the appropriate annuity-due. Thus $b'_{x\overline{n}|} = \dfrac{B'_{x:\overline{n}|}}{a_{x:\overline{n}|}}$.

The values of a simple bonus are proportional to the rate, and if they are worked out for a one per cent. bonus, it is a matter of simple proportion to find the values at any other rate. This convenient rule does not hold in the case of compound bonuses, and as the exact expression for a compound bonus is somewhat unwieldy, the values of a 30s. bonus were computed by an approximate method as follows: If the bonus be treated as compounding yearly (which probably will not produce any serious error), the present value at 4 per cent. of a compound reversionary bonus of 30s. may be represented thus :—

$$\frac{\cdot 015\, C_x + (1\cdot 015)^2 \cdot C_{x+1} + (1\cdot 015)^3 \cdot C_{x+2} + \cdots + (1\cdot 015)^n C_{x+n-1} + (1\cdot 015)^n D_{x+n}}{D_x} - A_{x:}$$

$$\frac{1\cdot 015}{1\cdot 04} \cdot \frac{d_x}{l_x} + \left(\frac{1\cdot 015}{1\cdot 04}\right)^2 \cdot \frac{d_{x+1}}{l_x} + \left(\frac{1\cdot 015}{1\cdot 04}\right)^3 \cdot \frac{d_{x+2}}{l_x} + \cdots + \left(\frac{1\cdot 015}{1\cdot 04}\right)^n \cdot \frac{d_{x+n-1}}{l_x} + \left(\frac{1\cdot 015}{1\cdot 04}\right)^n \cdot \frac{l_{x+n}}{l_x} \Big\} - A$$

ut $\dfrac{1\cdot 015}{1\cdot 04} = \dfrac{1}{1\cdot 02463} = \dfrac{1}{1\cdot 025}$ (approximately), and substituting the latter value we h

$$\frac{1}{1\cdot 025} \cdot \frac{d_x}{l_x} + \left(\frac{1}{1\cdot 025}\right)^2 \cdot \frac{d_{x+1}}{l_x} + \left(\frac{1}{1\cdot 025}\right)^3 \cdot \frac{d_{x+2}}{l_x} + \cdots + \left(\frac{1}{1\cdot 025}\right)^n \cdot \frac{d_{x+n-1}}{l_x} + \left(\frac{1}{1\cdot 025}\right)^n \cdot \frac{l_{x+n}}{l_x} \Big\} - A$$

$: A_{x:\overline{n}|}(2\tfrac{1}{2}\%) - A_{x:\overline{n}|}(4\%)$.

It will be noticed that the two approximations act in opposite directions and incline to balance one another; the first—compounding the bonuses yearly—tends to increase the value unduly, and the influence of the second—taking $1\cdot 02463 = 1\cdot 025$—is to reduce the value again. The true value of $b'_{30:\overline{20}|}$, for instance, is 1·097, while the approximate formula brings out 1·102; the true value of $b'_{30:\overline{35}|}$ is ·9162 and the approximate ·9205, in each case a difference of 1d. per cent. in the annual premium.

TABLE A.

Value of Simple Reversionary Bonus of 30s. p. c. p. a. H^M 4%. $100\,B_{x:\overline{n}\rceil}$				$100\,B_{x\,\overline{n}\rceil}$
x	$x+n=$ 50	$x+n=$ 55	$x+n=$ 60	$x+n=$ 65
30	12·962	13·259	13·128	12·779
35	11·860	12·842	13·123	13·004
40	9·718	11·744	12·676	12·934
45	6·021	9·614	11·550	12·408
50		5·978	9·464	11·268
55			5·916	9·231
60				5·813
Annual bonus loading at age 30. $100b_{x:\overline{n}\rceil}$	·987	·897	·819	·757

TABLE B.

(Approximate Method.)

Value of Compound Reversionary Bonus of 30s. p. c. p. a. H^M 4%. $100\,B'_{x:\overline{n}\rceil}$				$100\,B'_{x\,\overline{n}\rceil}$
x	$x+n=$ 50	$x+n=$ 55	$x+n=$ 60	$x+n=$ 65
30	14·466	15·283	15·581	15·555
35	12·784	14·312	15·082	15·353
40	10·113	12·648	14·098	14·802
45	6·021	10·000	12·423	13·756
50		5·978	9·837	12·094
55			5·916	9·584
60				5·813
Annual bonus loading at age 30. $100b'_{x:\overline{n}\rceil}$	1·102	1·034	·973	·921

ADDITIONAL RESERVE to maintain the rate of bonus at 30s. p. c. p. a. when a true valuation is made. H^M 4%. Policy for £100. Age at Entry, 30.

TABLE C.

Simple Bonus. $100\,\{B_{x+m:\overline{n-m}\rceil} - b_{x:\overline{n}\rceil} \cdot a_{x+m:\overline{n-m}\rceil}\}$				
No. of years in force (m).	$x+n=$ 50	$x+n=$ 55	$x+n=$ 60	$x+n=$ 65
5	1·139	1·217	1·231	1·169
10	1·771	2·120	2·259	2·229
15	1·564	2·478	2·940	3·068
20		1·958	3·062	3·549
25			2·285	3·477
30				2·518

TABLE D.

(Approximate Method.)

Compound Bonus. $100\,\{B'_{x+m:\overline{n-m}\rceil}\,(1{\cdot}075)^{\frac{m}{5}} - b'_{x:\overline{n}\rceil} \cdot a_{x+m:\overline{n-m}\rceil}\}$					
No. of years in force (m).	$(1{\cdot}075)^{\frac{m}{5}}$	$x+n=$ 50	$x+n=$ 55	$x+n=$ 60	$x+n=$ 65
5	1·075	1·773	1·985	2·085	2·105
10	1·156	2·818	3·527	3·921	4·087
15	1·242	2·502	4·193	5·200	5·721
20	1·335		3·345	5·527	6·754
25	1·436			4·180	6·761
30	1·543				4·960

Simple Bonus.

Additional Reserve obtained by means of an interest margin of

One-half of one per cent. | Three-quarters of one per cent.

Table E.

$$100\{{}_mV_{x:\overline{n}|}(3\tfrac{1}{2}\%) - {}_mV_{x:\overline{n}|}(4\%)\} + 1{\cdot}5m\{A_{x+m:\overline{n-m}|}(3\tfrac{1}{2}\%) - A_{x+m:\overline{n-m}|}(4\%)\}$$

No. of years in force (m).	$1{\cdot}5m$	$x+n=$ 50	$x+n=$ 55	$x+n=$ 60	$x+n=$ 65
5	7·5	1·031	1·028	·991	·937
10	15	1·612	1·800	1·837	1·796
15	22·5	1·433	2·119	2·414	2·489
20	30		1·685	2·535	2·903
25	37·5			1·906	2·865
30	45				2·091

Table F.

$$100\{{}_mV_{x:\overline{n}|}(3\tfrac{1}{4}\%) - {}_mV_{x:\overline{n}|}(4\%)\} + 1{\cdot}5m\{A_{x+m:\overline{n-m}|}(3\tfrac{1}{4}\%) - A_{x+m:\overline{n-m}|}(4\%)\}$$

$x+n=$ 50	$x+n=$ 55	$x+n=$ 60	$x+n=$ 65	No. of years in force (m).
1·562	1·565	1·515	1·439	5
2·433	2·730	2·799	2·746	10
2·152	3·199	3·661	3·789	15
	2·532	3·828	4·402	20
		2·865	4·327	25
			3·141	30

Compound Bonus.

Additional Reserve obtained by means of an interest margin of

Three-quarters of one per cent. | One per cent.

Table G.

$$100\{{}_mV_{x:\overline{n}|}(3\tfrac{1}{4}\%) - {}_mV_{x:\overline{n}|}(4\%)\} + 100\{(1{\cdot}075)^{\frac{m}{5}} - 1\}\{A_{x+m:\overline{n-m}|}(3\tfrac{1}{4}\%) - A_{x+m:\overline{n-m}|}(4\%)\}$$

No. of years in force (m).	$100\{(1{\cdot}075)^{\frac{m}{5}} - 1\}$	$x+n=$ 50	$x+n=$ 55	$x+n=$ 60	$x+n=$ 65
5	7·5	1·562	1·565	1·515	1·439
10	15·6	2·462	2·766	2·838	2·787
15	24·2	2·202	3·280	3·761	3·898
20	33 5		2·635	3·993	4·602
25	43·6			3·042	4·608
30	54·3				3·406

Table H.

$$100\{{}_mV_{x:\overline{n}|}(3\%) - {}_mV_{x:\overline{n}|}(4\%)\} + 100\{(1{\cdot}075)^{\frac{m}{5}} - 1\}\{A_{x+m:\overline{n-m}|}(3\%) - A_{x+m:\overline{n-m}|}(4\%)\}$$

$x+n=$ 50	$x+n=$ 55	$x+n=$ 60	$x+n=$ 65	No. of years in force (m).
2·106	2·120	2·061	1·965	5
3·305	3·729	3·844	3·790	10
2·942	4·404	5·071	5·281	15
	3·521	5·360	6·207	20
		4·064	6·188	25
			4·554	30

Examination of these tables would seem to point to the conclusion that in so far as Simple Bonus policies are concerned, the inferences already drawn with regard to the interest margin necessary for the maintenance of the rate of bonus under Whole Life policies are equally applicable to Endowment Assurances.

For Compound Bonus policies, however, it appears to be indicated that even an interest margin of 1 per cent. is barely sufficient, under the conditions assumed, to uphold the bonus rate. One was scarcely prepared to expect this conclusion, and Tables I and J were therefore constructed in case the result might be due to the inaccuracy of the approximate method employed, but comparison of Table J with Table D only serves to show how close was the approximation, and in further pursuit of the inquiry this method was reverted to.

From the trend of the tables, it looked as if the deficiency in the 1 per cent. interest margin would be even more marked in the case of Whole Life policies, and this supposition was confirmed by Tables K, L, and M. That the deficit is not made good out of superfluous loading is proved in Table N, where the annual premiums for a 30s. bonus at H^M 4 per cent. are compared with the annual surplus margins which remain after deducting from the premiums charged by the Compound Reversionary Bonus Offices (*J.I.A.*, xxxii. 337), first, commission at $2\frac{1}{2}$ per cent., and second, the H^M 4 per cent. valuation premium, leaving all other expenses to be met from extraneous sources.

The general conclusion seems to be that a Compound Bonus Office anxious to maintain a 30s. bonus will have to make a considerable amount of miscellaneous profit before it can be satisfied with an interest margin of 1 per cent.

TABLE I.

ue value of Compound Reversionary Bonus of 30s. per cent. per annum —H^M 4%.

$100\ B'_{x\,\overline{n}|}$

;	$x+n=$ 50	$x+n=$ 55	$x+n=$ 60	$x+n=$ 65
0	14·400	15·212	15·507	15·482
5	12·727	14·247	15·014	15·283
0	10·070	12·593	14·037	14·737
5	6·021	9·959	12·370	13·698
0		5·978	9·798	12·046
5			5·916	9·549
0				5·813
ual us ling ge	1·097	1·029	·968	·916

TABLE J.

(Exact Method.)

Additional Reserve required to maintain the bonus rate.

Age at Entry, 30.

$100\{B'_{x+m:\overline{n-m}|}(1{\cdot}075)^{\frac{m}{5}} - b'_{x\,\overline{n}|} \cdot a_{x+m:\overline{n-m}|}\}$

No. of years in force (m).	$(1{\cdot}075)^{\frac{m}{5}}$	$x+n=$ 50	$x+n=$ 55	$x+n=$ 60	$x+n=$ 65
5	1·075	1·766	1·979	2·085	2·108
10	1·156	2·808	3·518	3·914	4·084
15	1·242	2·524	4·182	5·187	5·710
20	1·335		3·366	5·514	6·741
25	1·436			4·204	6·749
30	1·543				4·981

TABLE K.

(Approx. method.)

Age (x).	Value of Compound Reversionary Bonus of 30s. p.c. p.a. H^{m} 4%. $100\,B'_x$	Annual Bonus Loading. $100\,b'_x$
20	14·224	·724
25	14·594	
30	14·820	·817
35	14·908	
40	14·812	·918
45	14·457	
50	13·844	
55	12·945	
60	11·775	
65	10·419	
70	8·899	
75	7·352	
80	5·965	
85	4·846	

TABLE L.

(Approximate method.)

Additional Reserve required to maintain Compound Bonus of 30s.

$$100\left\{B'_{x+m}(1{\cdot}075)^{\frac{m}{5}} - b'_x \cdot \mathbf{a}_{x+m}\right\}$$

No. of years in force (m).	$(1{\cdot}075)^{\frac{m}{5}}$	Age at Entry. 20	30	40
5	1·075	1·961	1·976	1·862
10	1·156	4·005	3·941	3·578
15	1·242	6·065	5·781	5·023
20	1·335	8·091	7·422	6·119
25	1·436	9·971	8·751	6·819
30	1·543	11·560	9·623	7·037
35	1·659	12·756	10·038	6·842
40	1·783	13·423	9·909	6·409
45	1·917	13·552	9·329	5·931
50	2·061	13·061	8·533	
55	2·216	12·069	7·749	
60	2·382	10·876		
65	2·560	9·756		

TABLE M.

Additional Reserve obtained by means of an interest margin of 1%.

$$100\left\{{}_mV_x(3\%) - {}_mV_x(4\%)\right\}$$
$$+100\left\{(1{\cdot}075)^{\frac{m}{5}} - 1\right\}\left\{A_{x+m}(3\%) - A_{x+m}(4\%)\right\}$$

No. of years in force (m).	$100\{(1{\cdot}075)^{\frac{m}{5}}-1\}$	Age at Entry. 20	30	40
5	7·5	1·538	1·666	1·732
10	15·6	3·134	3·309	3·292
15	24·2	4·739	4·838	4·580
20	33·5	6·309	6·178	5·519
25	43·6	7·755	7·239	6·077
30	54·3	8·971	7·915	6·199
35	65·9	9·871	8·198	5·950
40	78·3	10·354	8·035	5·497
45	91·7	10·415	7·503	5·014
50	106·1	9·999	6·803	
55	121·6	9·197	6·121	
60	138·2	8·242		
65	156·0	7·353		

Table N—Compound Reversionary Bonus Offices.

Office No.	Annual Surplus Margins.							Rate of Bonus at last Investigation.	
	Whole Life Ass'ces—Age at Entry			Endow^t. Ass'ces—Age at Entry 30—payable at				Whole Life Assurances.	Endowment Assurances.
	20	30	40	50	55	60	65		
(1)	·559	·691	·792	1·203	1 081	·967	·902	£1 6 0	£1 6 0
(2)*a*	·575	·712	·813	...	...	...	...	1 11 0	...
(3)	·575	·707	·813	1·041	1·041	·886	·784	1 11 0	1 11 0
(4)	·583	·688	·768	1·106	·984	·894	·829	2 0 0	2 0 0
(5)	·615	·761	·869	1·147	1·037	·950	·877	1 6 0	1 6 0
(6)	·645	·618	·674	1·021	·927	·858	·800	1 0 0	1 0 0
(7)*b*	·645	·695	·756	...	...	...	...	1 7 0	...
(8)	·737	·716	·817	1·155	·997	·894	·829	1 10 0	1 10 0
(9)*c*	...	...	...	...	...	...	...	...	...
(10)	·722	·806	·862	1·147	1·001	·906	·836	1 18 0	1 18 0
(11)*c*	...	...	...	...	...	...	...	...	...
(12)	·806	·732	·748	1·130	1·004	·931	·881	1 8 0	1 8 0
(13)	·806	·854	·878	1·151	1·053	·971	·914	1 10 0	1 10 0
(14)	·806	·781	·837	1·029	·956	·901	·857	1 8 0	1 8 0
(15)	·806	·854	·878	1·346	1·240	1·154	1·089	1 14 0	1 14 0
Average	·683	·740	·808	1·134	1·029	·937	·873	£1 9 11	£1 10 1
Annual 30s. bonus loading H=4% (approx.).	·724	·817	·918	1·102	1·034	·973	·921		

a Endowment Assurance bonuses are tontined. *b* Endowment Assurance bonuses are not compounded.
c No bonus yet declared under this system of distribution.

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Notes on Life Assurance in the United States of America

BY

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Notes on Life Assurance in the United States of America.

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My principal object in presenting this paper is to assist the student in his endeavour to obtain a knowledge of Life Insurance as it is practised in the United States of America, and to correct certain misconceptions regarding it among many of the older members of the profession.

The casual reader is apt to receive wrong impressions of Insurance in America through a want of knowledge of the conditions surrounding it. He is probably under the impression that nearly all American companies do business on the tontine plan, that new assurance is obtained at enormous cost, and that "Assessment Insurance" of the original type is the only system practised. Before proceeding to discuss these matters, it will be well to give a brief review of the history of Insurance in the United States. Without historical knowledge it is difficult to understand the legislative enactments regarding "Old Line" Insurance, or to realise the astonishingly large proportions to which Assessment Insurance has grown.

There are two distinct classes of companies — the "Legal Reserve" and "Non-Legal Reserve" companies. The former are so called because they are required by law to maintain a reserve based on a specified standard. These are the Legal or "Old Line" Companies. The Non-Legal Reserve Companies do not require to maintain any specified standard of reserve, and may be divided into "Fraternal Orders," "Assessment Associations," and "Flexible Premium Companies."

Standard of Valuation.

In connection with the Legal Reserve Companies, the State of Massachusetts, on Mr. Elizur Wright's advice, was the first to adopt the net valuation system. The table employed was the "Seventeen Offices' Experience," with interest at 4 per cent. This table is always referred to as the "Actuaries'" or "Combined Experience" table, and it is one of the curiosities of an up-to-date country that the "Seventeen Offices' Experience Table," compiled over half a century ago, is still in such repute.

The State of New York in the year 1866 followed the example of Massachusetts, and fixed upon the English Life Table (Male), No. 3, with 5 per cent. interest, which in 1868 was changed to the American Experience Table (Homan's), with 4½ per cent., and in 1887 to the Actuaries' Experience, with 4 per cent. The law passed in 1893, called the Roche Bill, permits the companies to select their own standard. In the words of the Superintendent of Insurance—"This Bill provides that all valuations made by the Superintendent shall be made according to the table of mortality adopted as the standard of valuation by the company for which such valuation is made." It was made inoperative on account of the refusal of other States to accept any standard less exacting than that prescribed by their own laws. In the early history of Insurance the necessity of compelling the companies to put aside an adequate reserve is evidenced by the very crude opinions which prevailed regarding "reserves." An eminent actuary even gave his approval to the valuation plan of one company, which showed a large surplus, by assuming that the old business would not cost anything for its care.

So far as I can discover, there is no record of Assessment Insurance in America until the year 1869. Assurance was therefore commenced on a correct basis, and there would probably have been no Assessment Insurance but for the want of confidence in Old Line Companies, caused by the many failures among their ranks. Up to the year 1870, insurance companies grew and multiplied. In that year and in the next few years there came a period of disaster, the details of which cannot be entered into in this paper. Suffice it to say that more than half of the companies were wiped out of existence in ten years.

Non-Legal Reserve Companies.—Under the conditions which I have mentioned, there is little wonder that the Assessment and Fraternal Associations came into existence in great numbers and received support from all classes of people. There were many things a layman could not fully understand, but which appeared to him to prove that the Old Line method was incorrect.

Fraternal Orders.—The assessment method was first practised by the Fraternal Orders. In their crude condition a fixed rate was collected at each death, irrespective of the age of the member, and the proceeds were paid to the beneficiaries. This system was followed by the payment of a stipulated sum to the beneficiaries, the basis of assessment being still the same. A number of companies divided their members into classes, the death losses of each class being paid by the members in that class. As there was no reserve fund, the assessments increased to such an extent that a friend of mine was

Crude Assessment Plans.

eventually assessed $500 on a $3000 policy. After explaining to him that the last man in the class would be required to pay the total death loss of the member preceding him, and that there would be no funds to pay the last man's claim, he decided to drop his policy. The company in which he insured was given a decent burial four years ago. One association charged a fixed premium each year for all ages from 15 to 55, and continued to pay the promised sum insured for many years. It seemed destined for a long life, but an investigation into its business methods caused lack of confidence in the management, with the result that the members resigned in large numbers, and the company went to pieces in a few months.

It was soon recognised that the assessments should vary with the age of the assured, and rules more or less crude were adopted, usually for every fifth age of entry. Thus a member who entered at age 25 would pay 5s. per assessment, while one who entered at age 55 would pay 10s. per assessment. The resulting inequality increased with the duration of the policy. At the tenth year of membership, the entrant at age 55 would only be paying twice instead of four times the amount required from the entrant at age 25.

As the Fraternal Orders are on one of the foregoing plans, with very few exceptions, prophetic vision is not needed to foresee the end. Unfortunately these orders and societies can be organised so easily that new ones spring up to take the place of those in a dying condition. The members who are in a good state of health abandon the decadent order in large numbers and thus hasten its end, leaving a number of the members in bad health without insurance. As the yearly death-rate is only from £4 to £5 in each £1000, and the expense charges are merely nominal, the *present* cost to the members is considerably less than yearly renewable term insurance in any Old Line Company. The marvellous cheapness in the early years largely accounts for the popularity of these orders. To this must be added the social element of the various lodges, which is a very large factor in many of the orders. It is not to be presumed that only the ignorant many are insured in them. Even the educated few hold policies, realising that they are obtaining insurance at a low cost, and taking their chance of being in sufficiently good health to obtain Old Line insurance when the Fraternal Order enters into its period of decay.

Growth and Decay.

Assessment Associations.—The rapid growth of the Fraternal Orders induced men to start associations on the same or a similar plan, with the exception that agents were employed, and

the Associations were conducted from a business, and not from a fraternal, standpoint. The plans adopted were:—

I. An equal rate of assessment, irrespective of age.

II. A rate of assessment varying only according to age at entry.

III. A rate of assessment in accordance with the age of entry and attained age.

With regard to the third class, an extra for contingencies was often added, which was apportioned among the survivors at the end of a certain number of years. It was estimated, and even promised, that the fund thus created would be sufficient to keep the cost from increasing at the end of a specified time—sometimes 20 years, but oftener at the expectation of life. Theoretically there was no objection to this plan, but practically the fund was not sufficient to keep the rate from increasing at the end of the period, and there was almost universal dissatisfaction. Their experience forced the management to conclude that many of their pet theories were untenable in practice. A development of the plans followed on the Legal Reserve Lines, the companies which made this advance being commonly known as Flexible Premium Companies.

Flexible Premium Companies.—This is the modern development of Assessment Insurance, and is midway between the Old Line and Assessment systems. Its distinctive features are:—

1st. A stipulated or flexible level premium in place of the increasing cost.

2nd. An expense loading which is fixed by the policy contract and is usually the same at all ages.

3rd. A provision for a reserve adequate to fulfil the conditions of the policy, on some basis mentioned therein, in accordance with the ideas of the management.

4th. The right to require the members to make up any deficit in reserve by an assessment.

This system has been adopted by many companies which at one time charged a natural or increasing premium. In some companies the rates are about the same as the Non-participating Premiums of Old Line Companies. Unfortunately many associations did not charge sufficiently high rates in their early years. The fear of dissatisfaction among old members led some companies to charge new members with a considerable share of the mortality under the old policies, thus impairing the reserve under new contracts. Many of them have now the services of recognised Old Line actuaries, who are endeavouring to put them on a

sound basis. As the right to make good any deficiency is recognised in the policy, the mistakes of the past can be cured unless there is too great a deficiency, and consequently too large a call to be made on the members.

The level-rate policies were adopted because it was recognised that the increasing assessment was unpopular. The new premiums purport to remain the same during a term of years or for life. These are usually called Level or Flexible Premium policies, and are offered on the term, whole life, and limited payment plans. The originators based their rates on various tables of mortality, and also used the lapse element in order to reduce the premium. Where there is a low lapse rate the reduction in premium is necessarily small, and would not, therefore, be much of a factor in Britain or Germany. The heavier lapse rate in the United States makes the reduction in premium quite considerable. In the beginning of the movement the premiums were calculated by merely taking a percentage deduction from the premium without lapse. The percentage was obtained in a very arbitrary manner, and if the premiums were based on a light mortality table, the rates were not reliable.

Basis of Premiums.

Improvements were made in the method of obtaining premium rates until a thoroughly sound method of calculation was obtained by Mr. L. G. Fouse. He calculated the lapse and death rate from the actual experience of certain Assessment Companies, and then proceeded to construct tables, which he called decrement tables, in the usual manner, with the additional factor of lapse. A novice constructing such tables is apt to consider the l_x column as a basis for the D_x, instead of constructing another column $l_x - \frac{1}{2}(\lambda_x + d_x)$, which may be called the payers. (Let λ symbolise the lapses.) If an annual premium is collected in the year of death, then the payers' column would be $l_x - \frac{1}{2}\lambda_x$. The rate of mortality (q_x) should not be multiplied into l_x, but into the actual number *at risk* in the middle of the year in order to obtain the number of deaths. The work is very laborious, as the lapse and death rates are different at each age of entry, thus necessitating commutation tables for each age at entry. To save labour, the commutation tables may be computed at quinquennial ages and the intermediate values interpolated.

Construction of Decrement Tables.

I have observed that the lapse rate *over a series of years* is nearly as regular as the rate of mortality in the company's own experience. The lapse rate varies in different companies, depending largely upon the method of obtaining new business. If the new applications are received under high pressure, large commissions being paid, the lapse rate will be heavier than in a company which pays moderate commissions. Of course, if a

company changes its method of doing business, its lapse rate would vary considerably. In stating that the lapse rate is regular over a series of years, it is presumed that like conditions as regards company's management prevail. One year cannot be compared with another year, as the business conditions of the community may be entirely different, but over a series of years there is likely to be an equal number of years of national prosperity and adversity. It is hardly necessary to mention that age has a most important bearing on the lapse rate, as may be seen by reference to Mr. Emory M'Clintock's work on "Selection."

One of the stock arguments of those who use the lapse rate is, "We do not require to carry such a large reserve as the Old Line Company." This is only true by reason of the lower mortality rates assumed in the calculations. They do not realise that if the lapse rate is employed, the contribution to reserve *per member* is less than under the regular method, but the *total reserve* at the end of any year is almost identical, provided the same table of mortality is used in both instances. In the former case, the contribution to reserve by the lapsed members swells the fund of the survivors, and in the latter it is transferred from reserve to surplus account, the member being only credited with his payment to reserve plus interest and benefit of survivorship from death alone. In referring to contribution to reserve, I mean the value at the beginning of the year of the reserve at end of year, or the net premium plus reserve at end of previous year minus the discounted cost of insurance, *i.e.*:—

Reserve when lapse factor is used.

$$v_n V_x = P_x + {}_{n-1}V_x - (1 - {}_nV_x) \times \frac{v d_{x+n-1}}{l_{x+n-1}}.$$

As this section of my subject is not of great interest to British actuaries, I shall not give a demonstration of the above facts. One use of the lapse factor in Britain would be in determining the reserve to be held to meet the declared dividend under deferred dividend policies. This would decrease the reserve, which is the opposite of the present tendency. The lapse element can also be employed in preparing tables and valuing policies for friendly societies.

While the use of the lapse factor is theoretically correct, the data on which the rates of most of the Flexible Premium Companies are based are considered unsafe by most actuaries. The often expressed idea of the leading men of the Flexible Premium system is to charge a premium which will be not more than sufficient to meet the policy conditions—in other words, they desire to discount all future profits. That being the case, we can readily understand that they will not adopt the mortality

rates which it would be necessary for an Old Line Company to employ. The mortality and lapse rates are sometimes taken from the "Thirty American Offices' Experience" (Meech), but oftener from the experience of Assessment Companies in general, or of an individual company. The premiums are lower in most cases than the regular non-participating policy. On objection being taken to the premiums on the ground of their being too low, the usual reply is that Old Line Companies make a profit on the non-participating business, otherwise they would not issue it. The "Prime Cost," "Cost Price," or "Anticipated Dividend" plans of the British companies also prove to the minds of the assessment advocates that the non-participating rates are too high.

Data for Death and Lapse Rates.

As the Assessment Companies claim to base their premiums on the true experience of death and lapse in the past, provision must be made in the event of the future being different from past experience. An assessment clause is therefore introduced which is commonly referred to as the "Safety Clause" or "Safety Valve." Several companies which charge an increasing premium make provision for a guarantee fund by a contribution, payable once only, of fifty cents for each year of the applicant's age. The reserve thus created is their safety fund which is to be used on the death-rate exceeding 1 per cent. per annum. One company, by reason of a large new business and careful selection, has had only half of 1 per cent. death-rate for the last fifteen years, and has therefore assumed that the reserve fund will never be required and can be returned to the member's estate at his death. The companies which charge a level premium divide it into mortuary, expense, and reserve elements. The policy provides that the reserve may be used to pay death losses in excess of the expected, but rarely provides for a condition when the reserve is exhausted. Other companies agree to lay aside 25 per cent. of the level premiums as an emergency fund which may be withdrawn at the end of five years or thereafter as a surrender value. If the remaining 75 per cent. be insufficient to meet the needs of the association, an assessment may be made. One association announces in its policy that the premium is based on the American $4\frac{1}{2}$ per cent. table and is amply sufficient—"but to maintain the absolute security of its policies, the company reserves the right, should the mortuary requirements of the company exceed the amount thus provided, to levy an additional premium," etc. No mention is made of the course to be pursued when the reserve is actually impaired.

Assessment Clause.

Only one company agrees to carry a reserve calculated by the usual formula:—$_nV_x = A_{x+n} - P_x(1 + a_{x+n})$. As a lapse element was used in the construction of the premium, it also enters into

the construction of A_x, P_x and a_x. As several companies only recently adopted premiums intended to be level for li for a period of years, insufficiency of these rates may be cov up for a number of years, especially when the clause only req an assessment in the event of the exhaustion of the reserve f and not on the proper reserve becoming impaired. In n instances premiums have been adopted which are only suffi to fulfil the policy conditions provided the lapse-rate be l the death-rate light, and the interest earned be 4 or 4½ per c The management have then proceeded to quote, and have actu given, surrender values, thus making the use of the safety assessment clause in the near future a necessity. For s people the lapse factor is a dangerous element, as they car be made to understand that surrender values must not be gi when lapse is used in calculation of the premium, and that reduced premium is the compensation to the insured for foreg surrender values.

A reform to which the assessment movement was pledged the reduction in the expense of obtaining new applications, in conducting the old business. It was thought that the l way to stop extravagant expense was to specify the policy the amount which could be used for t purpose. In the early days of the movement custom was to charge an entrance fee of—say—$10 per $1 policy, and $4 per $1000 annually for the expenses of the f and subsequent years. The greater part of the entrance fee paid to the agent, and the balance was usually sufficient to n the cost of writing the policy and the medical fees. This ref was on the right lines.

Expense Element of Premium.

It was soon found that the entrance fee prevented the age from getting new members owing to the competition of regular companies. It has accordingly been abolished, superseded by a fixed percentage or by all the first year's premi for first year's expenses, and a certain rate per thousand insura for the subsequent years' charges. At the present time it usual to state in the policy that the first year's premium may used in defraying the first year's expenses and cost of mortal The charge was made that Old Line Companies treated th policyholders inequitably by constructing gross premiums o percentage loading of the net premium, thereby assessing exper according to their age at entry.

It was necessary that the assessment advocates, in order to consistent, should charge a constant on the sum insured. S constant was from $2 to $5 per $1000 insurance. The Ass ment Associations made a mistake in loading by a consta because they are now being taxed a percentage on the premiu

by the various States, although the renewal commissions are computed on the amount of insurance. At one time Assessment Associations of all kinds were exempt from taxation, but now only "Fraternal Orders" escape the heavy burden on those who share one another's burdens. Several Flexible Premium Companies have had to increase their limitation for expense by inserting in policies a clause giving the management the right to charge taxes, and also the expense of settling death claims against the mortality or reserve account. Experience has shown that a Flexible Expense Income is almost as necessary as a Flexible Premium Income.

Variety of Policies.

As I mentioned previously, a large variety of policies is offered by the Flexible Premium Company. The most popular kind is ten, fifteen, and twenty year term insurance, with the right to change to any other plan without medical examination on paying the rate for the attained age. At the end of the period, the member may renew by paying the premium at the attained age, less his share of profits, if any, converted into an annuity. A whole life policy at a level rate, without any surrender value, is another popular form. They are also issuing limited payment policies with proportionate paid-up insurance, term extension, loans and cash values. The laws of many States will not allow the guaranteeing of those surrender values unless the full legal reserve is carried. The difficulty is met by dividing the premium into two parts, one for expense and mortality, and the other for reserve. A guarantee is then given to return the latter with its proper share of interest. The argument in competition against the Old Line Companies is that they will guarantee certain figures, the guarantee depending upon the ability of the company to carry it out. If the company has not the full legal reserve it will be put into the hands of Receivers, which means that the policyholders will get only a percentage of the figures guaranteed. The Flexible Premium Company, on the other hand, guarantees the fact that it will return the reserve element with its proper share of interest—the deduction being that the Old Line Company guarantees figures, while the Flexible Premium Company guarantees facts, and the latter is therefore the better of the two. In addition to the policies already mentioned, the Flexible Premium Companies occasionally issue return premium contracts—in fact, anything which does not come within the meaning of Endowment Insurance, as that is prohibited under many of the assessment laws.

Owing to the failure of several Flexible Premium Companies which did not charge sufficient premiums, many of the survivors have changed to the "Old Line" basis, eliminating the safety clause, and charging the same rates as the regular companies.

In fact the Flexible Premium plan seems to be but a stepping-stone to the "Old Line" system.

As the Flexible Premium Companies do not generally allow either loans or surrender values before the end of the seventh year, it will generally be conceded that the rates need only be slightly increased in order to make them "fixed" instead of "flexible." I have seen many annual dividend policies where the net cost of insurance is considerably less than the rates of the Flexible Premium Companies.

Limited Payment Premiums.

The Limited Payment Premiums are practically the same as non-participating rates of Old Line Companies. The policies are made participating at the end of the payment period. With inexpensive management, carefully selected risks, and a good investment of funds, some of the companies will be able to carry out the conditions of the policies which are now being sold.

It may be of interest to British actuaries to know that the whole life and limited payment life policies are often compared with the "cost price" plan. If the dividends show that a larger premium should have been charged, then those policyholders on the "cost price" plan are required to pay the deficit, or have it charged against the policy with interest. Similarly, if the reserve of the Flexible Premium Company is impaired, the deficit must be made good by assessments, or charged against the policy with interest, in those States where the latter course is not prohibited by law.

Mortality on Term Insurance.

The Flexible Premium Companies have been very much criticised for making term insurance one of their leading policies, because it is generally understood that term insurances induce a high mortality, owing to the personal selection of the applicant. Mr. Loveland of the North Western Insurance Company gave the following as an indication of the selection in his company:—

Plan.	Actual Loss.	Expected or Tabular Loss.	Ratio per cent. of Actual to Expected.
Term,	71,750	58,310	123.1
Non-Participating Life,	61,500	52,256	117.7
Ordinary Life,	6,540,078	7,815,412	83.7
Addition Life,[1]	650,296	837,224	77.7
Prepaid Life,[2]	3,094,957	4,406,407	70.2
Endowment,	2,054,286	3,238,042	63.4
Sum,	12,472,867	16,407,651	76.0

[1] Addition Life = ⅔ life and ⅓ term.
[2] Prepaid Life = Limited payment and fully paid life contracts.

Apparently the selection of the life was the principal cause of the difference in mortality. I am of opinion, however, that the rate of commission has a bearing on the matter. It is the custom to pay a very small commission in Old Line Companies on term insurance, which is not made attractive, with the result that the agent opposes the applicant in his desire to take term insurance, and only those who feel sure that they are *not* good lives will insist on taking such insurance, thus intensifying the selection. This view is confirmed by the result of an unpublished investigation into mortality in an Assessment Company, which showed that there was practically no difference in the death-rates between term and whole life insurance when the rates of commission were the same on both kinds. This is a partial answer to the criticism that the Flexible Premium Companies are committing suicide by taking so much term insurance at low premiums when the mortality is supposedly higher than on any other plan.

My excuse for going into a full explanation of these associations is twofold—

1st. Their modern development is not generally understood in Britain.

2nd. Their numbers and vitality make them serious rivals of the regular companies.

Concluding Remarks regarding Assessmentism.

The total amount of insurance in force in regular companies in the United States is about £1,100,000,000; and the Non-Legal Reserve Associations have a slightly larger amount at risk. A business which is as large, in one or two respects, as the Old Line, demands more study and consideration from managers and actuaries. The assessment system has done an immense amount of good by forcing many people to see the good of insurance who would not have taken Old Line policies. The Fraternal Orders have been, in innumerable instances, the kindergarten for agents and members of the regular companies. Notwithstanding the general condemnation of assessmentism, the failures of many Assessment Associations, and the large increase in assessments, it still has a great hold on the rank and file of the people—the social element of the lodges being a great factor in holding the members together. The amount of policies or certificates in force in these associations increased rapidly until two years ago, since which time it has remained about the same. Some Fraternal Orders may suffer, while others prosper. For instance, one association decreased from £32,000,000 insurance in force on the 1st of January 1894 to £9,000,000 on the 1st of January 1899, while another increased from £37,000,000 to £120,000,000 during the same period.

Old Line Insurance.—The growth of the regular companies in the United States of America has been phenomenal. In ten years the insurance in force has increased £560,000,000 sterling and the assets £150,000,000 sterling. During the year 1898 the new insurance paid for was £180,000,000 sterling, the premiums received £50,000,000, interest receipts £13,000,000, death claims paid £16,000,000, matured endowments £2,500,000. The cash paid for surrendered policies was £5,500,000, and the dividends allowed £4,000,000. On the 1st of January 1899 the insurance in force was £1,150,000,000, the assets £290,000,000, and the surplus on the basis of the Actuaries' 4 per cent. table £40,000,000.

I shall now take up the various points where there is a difference in practice between Great Britain and the United States.

Policy Values.—The first thing noticeable in looking over a policy issued in the United States is the table of surrender values. The granting of surrender values was first made compulsory by the State of Massachusetts, although many States have now similar statutes commonly called *Non-Forfeiture Laws.* As a rule the surrender values allowed by the companies are more liberal than those required by their home State.

In Britain it is the custom to state a rule in the policy or prospectus whereby a loan or surrender value may be computed.

Non-forfeitable Provisions.

In the United States of America tables are generally given, commencing with the second or third year, showing the cash, loan, paid-up and extended insurance values. The following gives a good idea of loan and surrender values in use in one of the most liberal of the companies:—

SPECIMEN TABLE INDORSED ON REGULAR POLICIES FOR $10,000. ISSUED AT AGE 40.

At end of year	LIFE POLICY—CONTINUOUS PREMIUMS OF $308.40.			
	In case of Surrender.	In case of Lapse of Policy.		
	Cash Value or Loan Value.	Extended Insurance.		*Or* Paid-up Policy.
		Years.	Days.	
2	$156.60	2	137	$620
3	292.30	3	206	920
4	432.90	4	262	1230
5	578.60	5	293	1530
6	729.30	6	289	1830
7	885.00	7	243	2120
8	1045.70	8	160	2410
9	1211.10	9	35	2700
10	1381.10	9	235	2980
11	1555.30	10	35	3250
12	1733.60	10	166	3520
13	1915.90	10	268	3780
14	2101.80	10	343	4040
15	2291.10	11	28	4290
20	3278.50	10	362	5430
25	4301.30	10	35	6380
30	5304.60	8	306	7160
35	6236.90	7	142	7770
40	7116.90	5	282	8270

After the policy has acquired a non-forfeiture value at the end of the second or third year, as the case may be, it is the practice to continue it in force, without payment of premium, for from one to six months. Before the end of that period the insured must either take paid-up insurance, reinstate the policy on proper evidence of good health, or accept extended insurance. If the insured does not choose any of these options, the company notifies him that his policy has become extended for a certain period, according to its terms, or that the company will retain the risk for the paid-up value.

As the reserve is used in purchasing temporary insurance according to one of the standard tables, slightly loaded, the extension is for a considerable period. For instance, a policy taken out at age 40 on the twenty-payment plan, and surrendered

at the end of the sixth year, would be extended for ten or eleven years. At the outset extended insurance was looked upon as a dangerous option, because it was thought that impaired lives might be prone to take advantage of its privileges if they expected to die within the extended period. To counteract this selection, it was the custom to deduct three annual premiums from the sum insured in the event of the insured dying within the first three years of the extension. This has been modified in recent practice until there are companies granting policies without provision for any deduction at death. This change in sentiment was brought about by the experience of several of the companies. The company which was most liberal in the term extension made a mortality investigation among those members who had taken advantage of the provision. The mortality was found to be 83 per cent. of the expected according to the American table. Curiously enough in the year in which the investigation was made the percentage of actual to expected deaths was 83 per cent. among the policyholders in general. As the percentage of actual to expected deaths ranges from 80 per cent. to 85 per cent. each year in the company in question, the mortality among its policyholders who are carried on term extension must be considered very favourable. It seems to be a fact, at the present time in any event, that there is no discrimination against the companies. Mention may be made of the practice of several companies which give the insured, who has taken advantage of the term extension, the privilege of reinstating his original policy at any time within the extension period by paying the back premiums with interest, and passing a satisfactory medical examination.

Extended Insurance.

A feature which would be noticed at once by British actuaries on inspecting an American policy is that there is a copy of the application, and usually a copy of part of the medical examination, printed on one of the pages of the policy. Some companies incorporate sufficient warranties in the application, so that it is only necessary to give a copy of the application with the insured's replies to the various questions. Other companies divide the medical reports into two parts. The first contains the insured's answers to questions regarding family and personal history, while the second gives the medical examiner's report of the risk. The former is incorporated in the policy by many companies. This system serves a double purpose. It protects the company against false statements and the insured against mistakes, as he has a copy of his replies to the questions which form the basis of his contract.

Copy of Application part of Policy.

Policy Conditions.—The general tendency is to make the

conditions of the policy as liberal as possible. There exists great diversity of treatment. The most liberal of the companies have no restriction regarding occupation, residence, travel, habits of life, or cause of death, after one or two years. One company has no restrictions in the policy of any kind from the date of issue. The indications are that people will pay more for a policy free from conditions than one which might work an injustice to the beneficiaries. The increased liberality may require either an increase in the premiums or a decrease in the dividends, but it will depend entirely upon the vigilance used in selecting risks. The company which grants an unrestricted policy takes the utmost care before issue to see that the insured is in good financial standing, is not likely to go to an unhealthy climate, or to change to a hazardous occupation, and is leading a moral and temperate life. There is one large company which issues a policy with many restrictions, even to the retaining of the right to cancel the policy in event of the insured becoming addicted to the excessive use of narcotics or intoxicants.

Suicide Clause.

There is great diversity of opinion regarding a suicide clause in the policy. The officers of those companies which retain it contend that the want of a suicide clause is against public morality, because it increases the number of suicides, and that it is also against business morality because it increases the cost to the honest policy-holder by decreasing the dividends. On the other hand, it is argued that the sum insured should be paid if the policy is applied for in good faith, that in a majority of cases the suicide is committed while insured is insane, through disease, business or family troubles, and that the beneficiaries should not be deprived of that protection which they most need. The percentage of suicides among the general population is less than among insured lives, but as the two are not homogeneous bodies, it does not prove that the protection of insurance makes a man more heedless of his life, though logically it would do so. It cannot be gainsaid that a small proportion of policies are taken out with suicidal intent in the event of certain contingencies, but there is little doubt that the courage of most of the people oozes away, or belief in self returns before the desperate deed is done. The proportion of those who take policies with suicidal intent and carry out their design is extremely small. If therefore a careful investigation is made as to a man's financial standing and business morality, losses of this nature can only amount to a small sum. The suicide clause for one year is a midway course followed by many companies, in the belief that it will deter the dishonest applicant from taking insurance in the particular company which has such restrictions.

A number of policies provide that when the insured g to tropical climes, an extra premium shall be charged co mensurate with the risk, or the sum insured sca at death.

Restrictions as to Travel.

The following are a few of the occupations commonly p hibited in the policy:—Retailing intoxicating liquors; handl electric wires and dynamos; blasting; mining; su marine labour; the manufacture of highly explos substances; service upon railroad trains, includ switching or coupling cars. Should the insured engage in a of these occupations an extra premium is charged, the amount the policy scaled, or the premiums returned and the pol cancelled. Policemen, liquor dealers, sea captains, and oth who experience an extra mortality, are charged an extra premi or are only issued short term Endowment policies under t deferred dividend plan in special classes, so that the additio cost of carrying the risk may be taken out of the dividends.

Restrictions as to Occupation.

The right of the policyholder to engage in military or na service in time of war received great attention l year owing to the war with Spain. The policies several companies have no restrictions to prevent citizen volunteering his assistance in time of war.

Military and Naval Service.

The practice of giving thirty days of grace in payment premiums is by no means universal; only 40 per cent. of companies give this privilege on payment of inter The custom in Britain is to charge no interest, w the result that the actual payment date is one month after nominal date in the policy. About 35 per cent. of the Ameri companies agree that the policy may be reinstated on satisfact evidence of good health within from one to twelve months. T other companies reinstate the policies on reasonable terms, thou they do not bind themselves to do so.

Days of Grace.

Variety of Policies.—There is endless variety of polic many being created to meet special conditions. A form insurance which prevents the principal being lost a bad investment or dishonest trustees is the Inst ment Policy. It provides that the sum insured shall be paya in five, ten, fifteen, twenty, twenty-five, or thirty instalments af the death of the insured. The rate of interest assumed by insurance company in calculating the premium depends on number of years over which the sum insured is payable. payable in five instalments, interest at $3\frac{1}{2}$ per cent. may be tak decreasing by, say, $\frac{1}{4}$ or $\frac{1}{8}$ of 1 per cent. for each five-y period thereafter. In the event of the death of the benefici before all instalments are paid, the remaining instalments

Instalment Policies.

commuted and paid to the heirs. Occasionally the insured will insist on the beneficiary having the right to commute the instalments at any time. This, however, defeats the primary object of the instalment policy, which is to provide an income without the chance of the loss of principal. The development of the Instalment Policy is the Continuous Instalment Contract, which provides for a continuation of the income during the life of the beneficiary should he or she survive the specified number of years. In the event of the beneficiary's death within the instalment period, the remaining instalments are payable as they come due to the heirs or are commuted into one sum. Under endowment insurance the Continuous Instalment feature may be adjusted to provide a continuous income to the beneficiary after the death of the insured, if within the endowment period, and a continuous income to the insured if *he* survive the endowment period.

Guaranteed Income Policies.

An interesting form of policy is the one commonly known as Guaranteed Interest Debenture or Income Bond. The company agrees to allow, say, 5 per cent. on the face value of the policy to the beneficiary for twenty years, and then to pay the face value. In the case of an endowment insurance, the insured would receive 5 per cent. on the principal at the maturity of the policy, and the principal itself would be due at his death or in some cases at the end of twenty years. The premium is computed by assuming that the company will be able to earn, say, 3 per cent. on its funds for the remainder of the contract after the death of the insured, or maturity of the policy. Provision is accordingly made in the premium for a deferred annuity of 1 per cent. if 4 per cent. interest is payable, or 2 per cent. if 5 per cent. interest is allowed.

Trust Certificates.

Another form which is becoming very popular among wealthy men is the Trust Certificate. In it the insurance company is nominated as the trustee, and agrees to pay a specified sum each year to the beneficiary out of the proceeds of the policy, and allow a certain percentage of interest on the balance in hand until exhausted. One company agrees to allow interest on the sum in hand at a rate not less than 3 per cent. It is earning about 4½ per cent. on its funds at this time and allows 4 per cent. on the trust funds which it is now disbursing, retaining the half of 1 per cent. for the expenses. The insured can select the amount of the annual payment which he desires to be paid to the beneficiary. At the death of the beneficiary the balance in hand is paid to the legal representatives, unless the insured has left instructions that the annuity be paid annually to a second nominee until balance is exhausted.

The result of the decreasing dividend on the tontine or

accumulation plan is the development of a policy which is referred to as a Guaranteed Dividend Policy. Despite its name it is non-participating. The premiums are computed by taking the difference between the participating and non-participating premiums for the same kind of policy and applying it in purchasing a pure endowment. Thus the premium for a twenty-payment policy for $2000 at age 35, on the participating plan is $70, on which the surplus which is being paid at the end of twenty years on policies now maturing, is $700. A Guaranteed Dividend Policy will provide $2000 insurance at the same premium, and guarantee a dividend at the end of that time of about $400.

Guaranteed Dividend Policies.

Dividends.—It may be said that there are only two systems of sharing profits, others being very little in vogue. I refer to the Annual Dividend and the Semi-Tontine or Accumulation plans. There is as keen a difference of opinion regarding these two methods as there is regarding Assessment and Old Line insurance. The annual dividend plan is practised by a large number of companies, although the largest companies use the semi-tontine method. I shall first take up the former.

Some companies allow a dividend at the end of the second year in reduction of the third year's premium, while others allow the dividend on the second year's premium. It is hardly necessary to tell a body of actuaries that the dividend allowed on the second year's premium is not actually earned. It is the result of a system of distribution well suited to the case. There are two ways of looking at the treatment of initial expense—either to charge the entire cost against the first year's premium, or to distribute it over the duration of the policy. As the latter method is generally used in annual dividend calculations, a dividend can be paid on the second year's premium. The actual percentage of expense assumed is part of the confidential records of the various insurance companies. I may mention that it is customary to use a decreasing rate of expense, a select table of mortality, a lapse rate, and a rate of interest, all based on the company's past experience, properly modified to meet what is expected to be the future conditions.

Annual Dividend Method.

British actuaries have been so accustomed to hear the side of the opposition, that I shall confine myself to mentioning a few of the strong points of the accumulation or semi-tontine policy. It is many years since tontine insurance was issued in the United States. It does not provide for any surrender values in case of lapse or surrender, and therefore compels the insured to sacrifice his share of the reserve. Semi-tontine or accumulation insurance

Accumulation or Semi-Tontine Method.

provides for liberal surrender values and for the forfeiting of the profits only in the event of the termination of the policy before the expiration of the accumulation period selected by the insured.

First.—The hope of getting a substantial return during his own lifetime is one of the most powerful incentives to induce a man to insure.

Second.—By dividing profits, those who survive the accumulation period—twenty years in the majority of cases—get a substantial sum as an offset to the large returns to the heirs of those who die after paying a few premiums.

Third.—The system distinctly encourages the saving of money. The man who can regularly accumulate the dividends received under an annual dividend policy is very rarely met. Even if he has a desire to save, he has not the facilities for investing small sums. The accumulation plan forces him to save money.

Fourth.—The company is benefited by the lower mortality due principally to the applicant's selection. An applicant will not take a policy where the profits are deferred for twenty years unless he considers himself a good risk. He will select an annual dividend or a short accumulation period. The result of unpublished investigations by one or two of the companies who issue both annual dividend and accumulation policies, show that the latter have a lighter mortality than the former.

Mr. Loveland, to whom I have already referred, states in the *Transactions of the Actuarial Society of America*, vol. iv., "From a somewhat hasty examination of the calculations used in the distribution of mortality gains I derived the following, relating, however, to an experience of ten years only. Under a ten year deferred period, the average rate of mortality has been 70.7 per cent. of the expected, under the fifteen year period 62.2 per cent. of the expected, and under the twenty year period 59.6 per cent. of the expected. These figures relate wholly to semi-tontine insurance." The moral to be drawn from these figures is that the company which gives the applicant a choice of plans, should carefully scrutinise those who select the annual dividend plan.

Fifth.—The deferring of the benefit is a powerful incentive to keep the policy in force. It is therefore an advantage to the company in decreasing the lapse rate, which is very heavy in America compared with Great Britain.

So much has been heard of the actual dividends being less than the estimates, that the conclusion has been arrived at, by most people, that the managers and actuaries purposely misled the

applicants and agents. Such is not consistent with the facts. The figures showing the expected results were investigated by the best and most conservative actuaries in the country. The difference between actual and expected results was caused to a small extent by the decrease in rate of interest, and to a large extent by the lapse rate on tontine policies being far less than under previous annual dividend policies; and this change the wisest of men could not have foretold.

The method of treating semi-tontine or accumulation surplus is described by Mr. Rufus W. Weeks, Actuary of New York Life, in his published reply to the Russian Minister of Finance in August 1893; and I shall not attempt therefore to describe the method of treatment, except to say that the general lines are those with which the student is familiar under the "Contribution Plan" of Sheppard Homans.

Method of procuring New Business.—In Britain the insurance agent almost invariably carries on some other business such as a banker or a lawyer—insurance being merely a side issue. In the United States the insurance agent devotes his whole time to canvassing for insurance, making it a study and his sole business, thus becoming a trained expert, with the result that the Americans do a much larger new business, in proportion to the amount of insurance in force. The British insurance agent cannot have the same interest in the progress and welfare of his company as the American has in a company on which he is solely dependent for his living. The custom in Britain is to have a travelling inspector, who visits the agent in his district periodically, and is paid by salary and over-riding commission. Then there is the Secretary for the district, who has charge of one or more inspectors, and who has a salary and commission. While the commission paid to the local agent is small, the actual cost of obtaining new applications is larger than is usually supposed.

Treatment of Agents.

In the United States a man wishing to enter the insurance field must first serve as a sub-agent. He is paid a percentage on the first year's premium, and a small percentage on subsequent years' premiums, the renewal commission being frequently dependent on placing to his credit a certain amount of new business each year. If the sub-agent is successful he may be given a general agent's contract entitling him to employ agents. The first year's percentage of commission is not increased, but he will be given a larger renewal percentage on obtaining a new business yearly of say £50,000. Some companies give a general agent the exclusive right to obtain insurance, and to engage agents in a district or State. When a general

agent is paying his sub-agent the same commission on the first year's premium as he himself receives, he must either obtain new applications from personal canvass large enough to pay his expenses, or receive an allowance by the company until his renewal commissions give him enough to support those dependent upon him. A general agent whose income from renewals is sufficient for his needs, often devotes himself exclusively to helping his agents, and to procuring and educating new agents. Incompetency and aggressive competition cause many resignations, so that a general agent must be continually adding new sub-agents to his force in order to keep up his yearly business. There is always a superintendent of agencies, who is the connecting link between the agents and the management. He may be said to be the representative of the field force in the home office. A large company must, of course, have a considerable force of inspectors and supervisors, who are the assistants of the superintendent of agencies, in order to look after the appointment and welfare of general agents, to see that the wishes of the management are carried out, and in general, to make the agency force produce the most business without unnecessary expense. These men are paid by salary. In towns where there is sufficient old business in force to warrant the expense, a branch office is established with a cashier in charge. This relieves the general agent of the details arising from care of the old business, and allows him to devote his full energy to the obtaining of new applications. One "ordinary" company and several industrial companies are dealing direct with the agents. They have no general agents, but employ a few men on salary to supervise.

Agents' Commission.

One of the most important differences in the agency system in the two countries is that of allowance to agents. In Britain a commission is allowed on the amount insured during the first year, and a percentage on the second and subsequent years. Consequently, the first year's commission will be the same irrespective of the plan of insurance, and it is to the agent's interest to sell whole-life insurance when he has no renewal interest. In the United States a percentage on the first year's premium is given, varying for the higher priced policies. A smaller percentage is allowed on the 10 payment life than on a 15 payment life, and on a 10 year endowment than on a 15 year endowment, but not sufficient to induce agents to sell the lower price policies. Thus 50 per cent., 40 per cent., and 30 per cent. are allowed on 20, 15, and 10 payment life respectively. As few of the agents receive renewal commission, the first year's commission is the main consideration. No renewal commission is allowed, as already stated, unless a certain yearly

business is attained, while in Britain renewal commission is given in most instances without reference to the annual amount of new applications.

One result of the agent devoting his whole time to insurance is the system of giving advances, *i.e.* a monthly or weekly payment by the company, conditional on the agent paying the full premium to the company, without deducting commission. Of course a settlement is made periodically, and the balance due to the agent is paid. If there is a small balance against him no action is taken, as it may be wiped out before the next settlement. It happens on numerous occasions that the company has given the agent an advance in excess of his earning capacity, and the amount of the advance is accordingly reduced or the agent is dismissed. If the company is not protected by a bond or other security, it stands to lose on unproductive agents. Many companies make no allowances to agents, others do so if properly protected by a bond given by a friend who is financially responsible, and a few do not require the bond, but make very small advances. While the advancing of money by way of allowance to be charged against commission is not to be commended, it is hard to get agents without it. One company boasts that it has never lost any money on its agents, which may be due more to good luck than good management. The companies which make a large amount of advances to agents are either those which do a large volume of new business or those which find it hard to get agents, owing to some defect in the past or present management.

Advances to Agents.

Application Papers.—The application or proposal form is not greatly different from the one in use in Britain. While the names and addresses of two or three friends are requested, it is very rare that forms are sent to them to be filled out and signed. In place of the "private friend's" report, an inspection of the risk takes place. A mercantile or detective agency is requested to make a private investigation into the past and present habits, the history, and the financial condition of the applicant. When there is sufficient business from a city or district to warrant the expense, the company employs an inspector for its own risks. From what I have seen of the methods, I believe that the inspection of the risks is most efficacious in preventing the company from being imposed upon. It is a truism that friends will not tell the exact facts regarding a man's habits on account of their friendship, and accordingly the company has occasionally a poor risk imposed upon it. The inspector may err, but not through a desire to protect the man or his family—his duty is to the company.

Inspection of Risks.

In arranging for the medical report, great care is taken that the doctor is not a personal attendant of the applicant. It is a rare occurrence that a statement is required from the applicant's attendant in addition to the usual medical report. Those who wish more than, say £5000 of insurance, are examined by two physicians on different occasions. The examiners receive from three to five dollars for a report with chemical examination of urine, and an extra fee if a microscopic examination is required. In large cities a corps of physicians is kept, whose sole duty is to make examinations at request of the agents. Some companies pay salaries for these physicians in order to control their entire time.

Medical Report.

It is necessary to take the utmost precaution against fraud, because there is a considerable amount of it, due principally to the number of opportunities. People seldom live and die in the village or town in which they are born. Greater opportunity for advancement in the undeveloped portion of the West, the sending forth of men from the large firms to look after their interest in such places as are too far off to be managed by the principal office, and the large amount of emigration, tend to make an ever-changing population. An intimate knowledge of the history of one's neighbour is much harder to obtain than in an old settled country, because a man may enter a community and command the respect of his neighbours by right living, even though nothing is known of his antecedents.

Opportunities for Fraud.

Office Practice regarding New Applications.—In a number of companies a statement must accompany each application, stating that no rebate in premium has been or will be allowed or paid by the agent to the insured. Several State laws prohibit the agent from making an allowance, which is usually called rebating. There are heavy fines imposed both upon the giver and the receiver of a rebate, but convictions are very rare as it is difficult to obtain the necessary testimony. The evil is partly due to the large commissions paid for new business, and to the fact that few agents have an interest in renewal commissions. So long as an agent can afford to make a living by giving away a portion of his commissions, he will do so if it is necessary to secure the application. When commission is cut to such a point that the agent must retain all of it in order to make a proper living, and the public are educated to that knowledge, the practice will become less common. We shall no longer see an advertisement appearing in the newspapers at the end of each year, requesting bids for insurance at the lowest possible rate on the lives of several partners in a firm for

Rebating of Premium.

£20,000 each. Every insurance man understands that the firm in question has been obtaining insurance at a low cost for a number of years by receiving a very large rebate. At the end of the year bonuses are given in one or two large companies, if the agent obtains a certain amount of new business. If he only requires £5000 insurance to make good the amount, he can afford to give to the applicant more than his percentage of commission in order to earn the bonus.

Under-Average or Impaired Life Insurance.—Many companies at the present time have some plan for taking care of impaired lives. This is only now becoming general, and is not practised even yet to the same extent as it is in Britain. The first company, organised to do this business exclusively, commenced in 1888, but unfortunately was placed in the hands of Receivers in the autumn of 1899. Most of the risks were, however, reinsured by one of the newer under-average companies. It was conducted on the Assessment plan, and charged a lien against all policyholders, whether they were nearly first-class or badly impaired risks. The lien against the policy was decreased by the premiums paid.

History.

The second attempt was made in 1892 when a company was organised on the Old Line plan. Its first policy was a most ingenious one. The actuary desired to have a flexibility in the amount of mortality which the company could sustain, as it was so much of an experiment. He accordingly devised a policy with a single premium which increased with advancing age, but decreased by the reversionary additions added from profits each year. If the company had a good year, it could reduce the lien considerably, but if the income for mortality was not sufficient to meet the death losses no dividend need be declared, and, consequently, the lien was increased for the succeeding year. It protected the company effectively, but was not popular with the public.

A third company was organised in 1895. It charged an extra premium or an equivalent lien according to the desire of the insured. From an insurance standpoint it has had a large measure of success, but the finances have been so badly managed that the original capital of the company (£70,000) was dissipated within four years. Within the last few months additional capital of £140,000 has been raised, and the company will undoubtedly be made a success if the management profit by their past experience. These three companies all suffered severely from fraudulent cases imposed upon them.

The company which is doing the great bulk of the under-average business in the country is the New York Life. It issues

all kinds of policies with varying liens and extra premiums to correspond. By the system of varying liens it can afford to take a very poor risk. For instance, a man may have a form of heart disease which is considered dangerous by the medical board, and accordingly an offer is made of a policy with a lien of $700 per $1000 and at a premium of $100, on the ten year endowment plan. The lien decreases in accordance with the premiums paid, and the company is only at risk the first year for $300, on which the insured has paid a premium of $100. This is, of course, an extreme case. The experiment has met with a large measure of success owing to the great care with which the lives have been inspected and the good judgment employed in rating the risks. In order to rate risks accurately, most extensive investigations have been made into the mortality of the declined risks of the company, with the result that a thorough knowledge of the mortality has been obtained among all classes of impaired risks. I may state that there is no "Rule of Thumb" method in use in the New York Life, such as adding ten years to the age of the insured for albuminuria, whether he be aged twenty or sixty. The ratings are based on the statistics deduced from observations on persons having the particular disease or impairment under consideration, and not upon the impressions of the medical director as to what the mortality would be. As already mentioned, the rate of mortality was obtained by compiling the statistics on the declined cases. Records of the declined cases were furnished to the Inspection Department, who made searches in order to discover whether the men were now living or dead, and if dead, the date and cause of death. The statistics were arranged and selected according to impairment by the Medical Department, and the necessary calculations made by the Actuarial Department. The deductions from the statistics have not been made public.

System of Operation.

Insurance on the Lives of Women.—There is more uniformity of custom in Britain regarding the insurance of women than in the United States, where the companies early discovered that the mortality was somewhat higher among women than among men, and accordingly most of them refused to accept risks on women except at an extra premium. A few companies, notably the New England Mutual, continued to insure women, but under special conditions so as to eliminate moral hazard. Policies were issued on women whose husbands were impaired so as to prevent them from earning a living, or widows who had dependent children, or spinsters who had some one depending upon them for support. This prevented the insuring of wives by their husbands, when the latter knew that the former had some

disease that would cause a fatal issue in the near future. It also prevented speculation in female risks. The published experience of the New England Insurance Company shows that the mortality amongst women, which were virtually specially selected, was slightly better than amongst men. Those companies which have adopted the same method have also had a favourable experience. It is a noteworthy fact that some of the Fraternal Associations have had a very favourable mortality amongst women when they were accepted upon the same terms as men. This may be accounted for by the insurance being small and by the social element being a factor of considerable importance. In this connection it may be well to mention that nearly all companies have discontinued writing Joint Life Policies upon husbands and wives, because it was found that the mortality was higher than the normal.

Post-Tontine Mortality.—It has been well known to actuaries that the mortality after the end of the tontine or accumulation period was very high. This is a natural result of the selection allowed the insured. He may select—

1st. The dividend and reserve in cash.
2nd. An annuity for such a sum as dividend and reserve will purchase; and
3rd. The dividend and reserve converted into paid-up insurance on satisfactory medical examination; or
4th. The dividend in cash and continue the policy in force.

If the insured be a good risk at the end of the ten, fifteen, or twenty year accumulation period, he will undoubtedly select one of the first three options, and if he be a poor risk, he will choose the last option in order to get as much as possible for his family. No experience has been published showing the post-tontine mortality, which probably varies for each accumulation period, but it is generally understood that investigations have been made in all the companies using this method of distributing the surplus.

State Supervision.—It is well known that the companies have to submit to supervision by every State in the Union. As the position of Insurance Commissioner is a political appointment, it naturally follows that the companies have to stand with patience many vexatious requests and directions from some of the Commissioners who do not understand the business thoroughly. Insurance supervision is not an unmitigated evil, though it could be improved so that it would be an undoubted blessing if national supervision were introduced. There is a movement on foot at the present time to have national instead of state supervision.

There are legal difficulties in the way which may delay the matter for many years, but it will undoubtedly come. The annoyance of being supervised by over forty different Insurance Departments is gradually forcing the companies to seek relief, and the only feasible plan for relief seems to be national supervision.

Standard of Valuation.

As already mentioned, the State Laws prescribe what standard must be adopted in valuing policies. The most stringent standard is the Actuaries' 4 per cent. (17 Offices' Experience). Some of the States only require a reserve on American 4½ per cent., and the officials of such States are not in the habit of requiring a re-valuation by those companies which carry the Actuaries' 4 per cent. reserve. In a number of the States there is a law of reciprocity whereby the valuation of the Commissioner of the Home State is always accepted. This saves the companies a considerable amount of fees, and would be universally adopted but for the fact that it would cut down the income of the Insurance Departments of many of the States, especially in the southern and western parts of the country where there are few Head Offices of Insurance Companies.

Minimum Surrender Values.

In several States the law prescribes the minimum value to be allowed in case the policy is lapsed. The law of Massachusetts requires the reserve on the Actuaries' 4 per cent. table, less a surrender charge equal to 8 per cent. of the present value of all the normal future yearly costs of insurance—in other words, 8 per cent. of the net premium multiplied by the annuity for the whole of life or period of years for which the premiums are payable. The non-forfeiture law of New York requires a value which shall not be less than two-thirds of the reserve according to the American 4½ per cent. table. In some States a cash value is prescribed, while in others only paid-up or extended insurance must be given.

General Restrictions.

In one State paternalism is carried to such an extent that the law describes the manner in which the surplus shall be distributed. It further prescribes that no oral or written misrepresentation made in negotiating for the policy of insurance by the insured or in his behalf, shall defeat or avoid the policy, unless such misrepresentation is made with the actual intent to deceive, or unless the matter misrepresented increases the risk of loss. Another law states that the Company must pay the claim in event of the insured committing suicide, unless it be shown to the satisfaction of the Court or jury trying the case that the insured contemplated suicide at the time he made his application for the policy.

Laws against Discrimination.

There is a law in many of the States which prohibits discrimination between policyholders. It provides that no Life Insurance Corporation "shall make

any discrimination in favour of individuals of the same class or of the same expectation of life, either in amount of premium or in any return of premium, dividends, or other advantages." It further provides that there shall be no "distinction or discrimination between white persons or coloured persons, wholly or partially of African descent, as to the premiums or rates charged for policies upon the lives of such persons, or in any other manner whatever; nor shall any such corporation demand or require a greater premium from such coloured person than is at that time required by such corporation from white persons of the same age, sex, general condition of life, and prospect of longevity." Companies are never free from vexatious legislation.

Taxation.

The taxation of Insurance Companies does not cause so much grumbling as when the consumer is taxed direct, and accordingly the Insurance Companies have to stand a large share of the taxation. Savings Banks are not taxed, because legislators understand that they are the depositaries of the thrift of the people, and should accordingly be encouraged in every legitimate manner. Neither the people nor the legislators fully realise that Insurance Companies are equally deserving of the same consideration as Savings Banks. Some States charge a percentage on all premiums collected in the State and allow the various cities to charge a fee for each agent. One State following this method taxes 3 per cent. of the premium and $100 per year for each agent. It is only fair to state that the enlightened legislators in some of the States only require the companies to pay a small fee for each agent appointed, reasonable fees for examining companies and valuing policies, and do not charge taxes on the premiums collected. In Mr. M'Call's paper already referred to, he shows that his company had to pay taxes on premiums representing $630,100,000 out of $877,000,000 insurance in force. The taxes were very nearly $200,000, a very considerable item indeed.

Stamp Duties.

Prior to the war with Spain the companies were not required to put stamps on their policies, or for that matter on any other legal document. The stamp-duty was operative during the Civil War, but not since that time, as it was essentially a war measure. The Insurance Companies now pay a tax of 80 cents. on each $1000 policy, or 1s. 8d. on each £100 policy. Some of the companies pay the policy tax themselves, while others require the agent or the insured to pay it.

Annual Valuations.

Annual valuations are required by all States, and the result of the valuation in some instances must be communicated to the State within one month from the end of the year. The company with which I am connected actually had a full statement printed, giving details of the valuation,

insurance in force, amount of funds, receipts, disbursements, assets, and liabilities, on the 7th of January, or seven days after the books were closed. In order to accomplish this, a vast amount of forethought and hard work is required, especially when it is considered that the policies are valued singly and not in groups, except for the purpose of checking the accuracy of the work. The result of this system is that before the end of January the condition of nearly all the companies is published in the daily papers. Some of the official State reports are ready for use in March, and comparisons can then be instituted between the companies under like conditions. We have no such anomaly as receiving the Board of Trade statement in the middle of the year containing a statement of the condition of the companies for a year to a year and a half prior to the issuance of the report.

The amount of information required by the various States is diversified in its nature. A number of the officials arranged about three years ago to have one blank form applicable to all the States with which they were connected, about eighteen in number, and I shall give a synopsis of it. It calls for information of the most searching character on their financial condition. The income during the calendar year (no other period is allowed) is divided into sums received for old and new premiums, annuity consideration, interest, and miscellaneous income. The interest income must be furnished according to the method of investment, such as dividends on stocks, interest on mortgages, rents on company's property, etc.

Synopsis of Annual Statement.

The disbursement account contains about twenty items. The payments to policyholders must be divided into death claims, matured endowments, dividends to policyholders, surrender values, and instalments on trust policies. The general expenses of the company must show first year's commission, bonuses and advances to agents, renewal commissions, salaries of the managers and others connected with the agency department, home office salaries, medical examiners' fees, cost of inspection of risks, taxes and licences, rent, advertising, printing and stationery, postage and telegrams, and real estate charges. All other items not coming within the above items must be given separately, along with the purpose for which each disbursement was made.

In addition to the summary of the assets, divided into bonds and stocks, real estate, loans on real estate, cash, loans on company's policies, premium rates, loans on bonds and stocks and agency ledger balance, we are required to give the market value of bonds and stocks over book value, and interest on loans, etc., due and accrued. A further item in the assets, viz., premiums

According to the valuation system in vogue in Great Britain, the loading earned on premiums of insurance and on annuity considerations can readily be obtained, because the net premiums are valued. In America, however, the net premiums are not valued—the tabular reserve, according to the specified table, being employed in each case. The only exception to this is when the gross premium charged by the company is less than the net premium according to the standard table. The cost of insurance is obtained by multiplying the face value of the policies, less reserve, by the rate of mortality, q_x. The cost of insurance has received great attention in America. In the various tables published by actuaries, the cost of insurance is always given.

Credits.

Considerable labour is caused by keeping a record of all policies released by surrender and lapse, which is principally made up from those policies which have not been in force a sufficient number of years to have acquired a surrender value. The expenses incurred must be divided into insurance expenses and investment expenses, the latter including repairs, taxes on and expenses of real estate, and also cost of handling investments. The interest required to maintain reserve is easily obtained, a good formula being the one suggested by Mr. Wells in vol. ii. of the *Transactions of the Actuarial Society of America.* As credit is given with the net cost of insurance on the actual amount at risk, the debits contain the actual death losses, less reserve, and also payments to annuitants less amount released by death of annuitants. The next two items, those for surrenders and dividends, do not call for special mention, as they have to be prepared in any event for the general statement.

Debits.

I need hardly point out to a body of actuaries that the Gain and Loss Statement has added a vast amount of extra work to the actuarial departments of the various companies. It has served a good purpose in pointing out the weaknesses of several. Those companies in which the expenses were greater than the expense loading have been severely criticised in various insurance periodicals, and they are, consequently, endeavouring to mend their ways. It also has served a good purpose in showing the public generally that there is not a large profit from lapses. As the reserves realised by surrender and lapse are divided into those having a surrender value, and those which have not such value, the profit from lapses can be very readily calculated by any one from the exhibit. Incidentally it shows how much margin the company has over and above the interest assumed in its reserve calculation, because the interest earned and the expense attendant thereto are given, and also the interest required to maintain the reserve. The cost of insurance and the

Advantages of Exhibit.

death losses incurred being given, the percentage of expected to actual mortality can be found.

Industrial Companies.—There are two industrial companies which do practically all the business in this country. So far as I can gather the method of conducting the industrial business is not greatly different from that in vogue in Great Britain. The insurance in force at the end of 1899 under the industrial plan was about £210,000,000. It has not assumed the same dimensions as in Britain because it is of a younger growth, and more of the artisan class can afford to carry "ordinary" insurance. The Gain and Loss Exhibit has shown the insurance world that the mortality among industrial risks is very high. The business expenses are not unduly high when it is considered that the average weekly payment is about fivepence, and the average sum insured about £25. Some time ago I had occasion to compare the expenses of industrial companies, and found that the percentage of expense and commission to premiums in America was about 53 per cent., against 44 per cent. in Great Britain. On the other hand, the former companies earned fully 1½ per cent. more on their investments than the latter.

The industrial companies have recently entered the "ordinary" field, and are becoming strong competitors of those companies which transact "ordinary" business only. They are making a speciality of non-participating insurance at very low rates, which they can afford to do if their industrial business can be made to bear a portion of the expense of the ordinary branch. The moment the industrial policyholders are made to bear a portion, even unwittingly, of the expense of obtaining new business under the "ordinary" branch, a great wrong is done. Insurance of such magnitude should be considered a national institution for the good of the people, and not for the benefit of individual stockholders who have been more than repaid for any risk they may have run. Insurance to be conducted properly must be taken from the realm of mere business barter.

Expense Ratios.—It has been contended that while the American companies pay larger commissions than those in Britain, the actual expense rate in the former country is quite as low as in the latter, because the volume of new business is much larger. My investigations do not show this to be the case. There are three recognised methods of comparing expenses:—

1st. Ratio of gross expenses of management to each £1000 mean insurance in force.

2nd. Ratio of gross expenses of management to total income or to premium income.

3rd. Cost of new business after allowing 7½ per cent. or 10 per cent. of the renewal premiums for care of the old business.

It is somewhat difficult to obtain an exact comparison, because the Board of Trade Returns do not give the results of the business by calendar years. My results must therefore be taken as approximate. Excluding industrial insurance, the first method shows a ratio of £9 in the United States against £5 per £1000 in Britain. By the second method the ratio of expense to total income is 20 per cent. against 11 per cent., and the ratio of expenses to premium income is 26 per cent. against 14 per cent. The larger volume of new business in the United States can be realised from the fact that the commissions are about 50 per cent. of the gross expenses, including commissions, and only 35 per cent. in Britain. By the third method, if we allow 7½ per cent. as the cost of caring for old business, the expense of putting each £1000 of new policies on the books was £40 in the United States against £25 in Britain, or 140 per cent. of the first premium against 80 per cent.

Against the heavier expense of American companies may be set their larger profit from interest income. Taking all things into consideration, I should say that the average cost of a policy over a series of years in first-class companies in the two countries is about the same.

Method of Office Work.—While Britain is rightly credited with the introduction of the card system into life insurance, it has remained for the American companies to use it to its fullest extent. In my opinion they have carried it to excess. In one company the card system is used for all kinds of accounts, only a few books such as ledgers being retained. My experience has been with three companies, the first of which only used two sets of cards, the second employed cards for every conceivable purpose, and the third with judgment and moderation. As this section of my paper will no doubt be of interest to those who wish to improve the method of work in their office, I shall describe it at length. Before doing so, however, permit me to say that it requires considerable judgment to adapt the system to the peculiar needs of each company. There is no doubt in my mind that a large amount of saving both in time and energy can be effected by their use. The conservative manager who refuses to use them may be put in the class with those who will not freely use typewriters or telephones to facilitate business.

The actuarial card hardly needs description, as it is in use in most companies. Some companies prefer to have two cards—

one for mortality and the other for valuation purposes. To my mind a single card is more desirable, as it saves the labour of keeping two sets up to date, and is less likely to lead to error. Of course it means more sorting, but the sorting is usually done by junior clerks, and is therefore one of the least expensive portions of the work. The card can also be used for actuarial correspondence, the information required for letters and calculations being given thereon. It is a good plan to have different colours in order to designate the plans at a glance. White, blue, red, and buff may represent Life, Term, Limited Payment, and Endowment policies respectively; while a fifth colour may be used for miscellaneous contracts. I found it a good plan to have an index-book numbered consecutively, showing the age of the insured, the State in which he resides, the plan of insurance, and the occupation. The labour of keeping this is a very small matter indeed, and it should be attended to daily. The reason for inserting the State in the index is because investigations are often required to show the expected and actual mortality in the various States, and the cards can readily be picked out by means of the index. For the same reason the occupation was inserted in the index. The cards should be arranged according to existing, not-taken, lapses and deaths. The existing should be kept according to the age at entry, and sub-divided according to the numerical order, which would give the duration of the policy, except when policies are dated back. The lapses and deaths may be kept according to age at entry and duration of the policy.

Actuarial Card.

Some Offices use Register Cards, which contain only such information as purely register books should contain. If any change is made in the policy the necessary alteration is made in red ink on the card. As no notice of premium payments are made on this card, they can be arranged numerically. The advantage of the card system as applied to registers is that the cards on lapsed and dead members can be kept separately, and the actual insurance in force be obtained by merely counting the cards. It is my opinion, however, that a register book is more useful than a register card. A register book is not subject to hard usage, and is seldom used when it does not contain a record of premiums. The late Mr. William D. Whiting, whose opinion is of great weight in such matters, informed me that he did not approve of register cards. He has inspected some books which had been in use forty-five years, and were still in good condition. He believed that a register should be a book of record which could not be tampered with in any way. Cards may purposely be misplaced, but it would be somewhat difficult to cut out pages from a register without being discovered.

Register Cards.

A card which is most useful is the Premium Card. It contains information for issuing premium notices and for recording payments by the members. In order to facilitate the work the card should be cut so that a portion is above the level. This is technically called a tab. If payments are made quarterly, there would be four tabs. When all premiums are made payable on a certain day of the month, the cards may be arranged numerically according to the months in which they are due, and sub-divided according to agencies, if desired. Small spaces may be left in order to fill in the date on which the premium has been paid. It is not necessary to enter the amount, the date serving all practical purposes. In order to check the work, a small space may be left after the date in which the word "paid" may be stamped.

Premium Cards.

There is little doubt that an index card is more satisfactory than even the best index book in the market. By the card system a minute or two is sufficient to get the policy number in the most difficult of cases. The index should contain a record of declined applications on different coloured cards. When applications are deferred, it materially lessens the office work by recording them on a third card, and those which have been applied for and not completed on a fourth card differently coloured from the other three. By an arrangement between a number of the companies, records of declined cases are furnished every day. Some companies most wisely write index cards for the declined cases of all companies and sort them among their own cards. All cards, whether for issued, declined, not-taken or postponed cases, should be sorted together in order to obtain the history of each.

Index Card.

A card for the Delinquent or Re-instatement Department is found very satisfactory. When a lapse occurs the facts are written on a card which the Delinquent Department keeps until a satisfactory reason for the insured lapsing his policy has been received, or until it is re-instated. Its employment has resulted in a better record being kept of lapses and in the reduction of the lapse rate on account of the increased attention which may be given to each individual case. Cards are also used for other purposes, such as a record of the interest payment on loans, mortgages, etc. Another is employed for keeping a synopsis of the agreements and contracts made with agents. The Medical Departments of some Companies write up a card for their declined cases giving the full particulars regarding family history, personal history, reason for declinature, and so on. These cards have been used in an interesting fashion by several companies. Circular letters in one instance were sent to all people mentioned in the application, *i.e.* friends and physicians.

Miscellaneous Cards.

They were requested to state whether the applicant was then living or dead; if dead, date and cause of death. The same information was obtained through the Inspection Department or mercantile agencies by another company. The information thus obtained was made a basis for rating up risks which had some impairment. I have not given the information contained on the cards above referred to, as each company must insert therein what is most suitable for its needs.

A daily cancellation book should be kept in the Delinquent or Premium Department. It should be sent around to every Department each day in order that the cancellations and re-instatements may be made with the least possible trouble, and in order that the card system in various parts of the Office may agree. Instead of writing the cards for new policies in each Department, it is found more satisfactory to have the cards for all Departments written by the policy-writer or his assistants. By this means the card system is always up to date, and does not run behind in accordance with the amount of current work which is to be done in each Department.

Investments in the United States for British Companies.—After watching the course of the money market for seven years, including a period of depression, a period of great political strife and anxiety, a period of war, and a period of prosperity, I am convinced that there is a splendid opening for the safe investment of the funds of British companies in the United States and Canada at more remunerative rates than obtain in Britain. The distrust of, and the prejudice against, all things American is gradually being broken down by a better knowledge of the true state of affairs in this continent. While I should like to correct a few of the misapprehensions regarding the foregoing, I must confine myself to the question of investment. In Mr. John Nicoll's paper on "A description of certain of the principal Stock Exchange Securities," he gives seven reasons why British Offices should have nothing to do with American securities. The most satisfactory way to answer his arguments would be to show that the profit and loss of the Investment Account was and is as favourable in American as in British companies. On referring to the Board of Trade Returns and the State Insurance Reports, however, I found that there were so many ways of treating the profit and loss on investments that no satisfactory comparison could be obtained. I shall therefore briefly answer one or two of Mr. Nicoll's arguments.

It is an undoubted fact that the laws and institutions of America are liable to greater change than in more settled communities. It must be conceded, however, that the change has

almost invariably been for the better, and in some instances where this was not so, the evil was remedied at an early date. I do not believe, and I have the advice of various authorities, that alien property can be confiscated by any one of the States, unless the owner does not fulfil the laws of the State. In event of war—which at the present time seems very improbable—the property of alien subjects who are not actively engaged against the Government would be respected. Even though a treaty did not exist covering this point, the confiscation of property is entirely out of date, and the tendency of things is against it. As Americans are now loaning money abroad, it is not likely that they will themselves endeavour to tax alien more heavily than domestic capital. With foreign possessions comes an extended outlook. The capitalists of America would strenuously oppose any law which would result in retaliation from the money centres of Europe. The rate of interest is decreasing both in the Colonies and in the United States, but it will continue to be higher than in Great Britain for many years. The fact that it is so diminishing is not a good argument against the investment of money in the United States. Please do not misunderstand the condition under which investments must be made in order to be both safe and remunerative. In order to test the advantage of investing in the United States, the method must be the same in both cases, *i.e.* the investment of the money should be undertaken by a man with a good financial knowledge, who has the interest of the company at heart and who has a thorough knowledge surrounding the investment of money in the United States. It will not do to send the Treasurer or the Financial Committee of the company to make investments, unless they are advised by, and will take the advice of, some reliable man who understands the situation.

Suggested Investments.

It is hardly necessary to give a synopsis of what I would advise as safe investments for British companies. Many of the dividend-paying stocks quoted on the London Stock Exchange, all bonds of first-class railroads, especially many which have been recently reorganised, are good investments. The names of such securities can be obtained from any firm of reliable brokers. The method of investment which I would urge upon the officers of British insurance companies is that of mortgages on property in the large cities. It goes without saying that property in the business centres of cities like New York, Chicago, Philadelphia, Baltimore, Washington, St. Louis, St. Paul, and San Francisco, are as safe as those in London, Glasgow, Manchester, or Liverpool. Mortgages can be obtained on either residential or business properties to the extent of one-half their cost price at rates of interest varying from 3½ per cent. to 4 per

cent., and even 4½ per cent., depending on the city and the location of the property. Those lenders who are afraid that the currency of the United States will be repudiated, and that the payment of interest or principal would be in silver, can have a gold clause inserted in the deed in most instances by cutting down the interest rate by ⅛ of 1 per cent. To those that wish to invest in mortgages such as I have described, a good way to protect themselves would be to lay aside a sinking fund out of the interest. If the mortgages returned 4½ per cent., then ½ of 1 per cent. might be carried yearly to a fund which would be appropriately named "Depreciation of Securities Fund," from which any losses in principal would be deducted. I cannot understand why a number of offices will invest in Canadian securities and mortgages and not in those of the United States, when the latter is a more settled country, where the conditions of prosperity are far more in evidence than in Canada. The matter undoubtedly deserves the careful consideration of every insurance manager in Great Britain. If he investigates the matter with an unbiassed mind, he can only come to one conclusion, namely, that he has delayed too long in investing a portion of the funds of his company in the United States.

General Remarks.—Before closing my paper a few desultory remarks would be in order. A young country may be compared to a young man who has more power of endurance than an older man, and can more rapidly recover from an illness. It takes a considerable period for an old country to enter a time of business depression, and it takes a correspondingly long time to get over it. A new country, on the other hand, rapidly passes from a time of prosperity into a period of depression, and as rapidly recovers itself. The old country has *depression* of business, the new country has *stagnation* of trade. The ups and downs are more marked in the latter than in the former. Any one who has watched the money market, which is the pulse of the country, can see the truth of my assertion. The very best stocks, including Government securities, were far below their true value in 1893 and 1894, while this year they are selling at a price beyond all previous records. Fluctuations to a certain extent are due to the temperament of the people, who are somewhat excitable.

The question often arises, why do British actuaries not hear more of their American brethren? The chief reason is they are kept too busy to prepare many papers of scientific research. The American actuary is rapidly becoming "a man of affairs," and not merely one who attends to the mathematical part of the business. He is expected to originate new plans of insurance, improve policy conditions, and suggest other changes which will suit the

insuring public. He accordingly must have a good idea of what people want, and not only what it is most desirable from an actuarial standpoint to submit to them.

Despite every endeavour my paper has extended to a greater length than I anticipated. The subject is so large that many matters of interest had to be omitted, and short explanations given in many instances which may not be explicit enough for the student. I trust, however, that a deeper interest has been created in American affairs, and sufficient information given to enable the student to understand insurance matters in the United States.

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Life Assurance in France

BY

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Life Assurance in France.

(*Read before the Actuarial Society of Edinburgh, 5th April* 1900.)

ONE of the most remarkable features in the history of the nineteenth century has been the rapidity with which some scientific discovery made in one country has been followed, and often eclipsed, by one on similar lines in another country. The reason for this is not far to seek, for he who would excel in any branch of science or learning must keep himself thoroughly acquainted with its latest developments, and with the progress it is making in all parts of the world. Thus, we find that a rivalry has sprung up, which grows keener every day, between this and the Continental countries in Science and Philosophy, as well as in Commerce and Politics. In this country, however, until quite recently, the insurance world in general, and the actuarial student in particular, have not considered it worth while to inquire how and upon what lines insurance business is carried on across the Channel. So far as I have been able to ascertain, the only books in the Faculty Library dealing with the subject of Life Assurance in France are Walford's *Insurance Cyclopædia*, published in 1876, and a pamphlet by H. S. Washburn in 1879. The object of this paper is to supplement to some small extent the information contained in these volumes, and to place materials in the hands of the Actuarial Society which will enable its members to form some idea of the progress and nature of life assurance business in France. We shall find that the business naturally flows into those channels which the character and genius of the French people would lead us to expect. As a nation the French are philosophical, but, at the same time, unpractical, provident, yet short-sighted, and above all—volatile. For years previous to the establishment of life assurance business in France, philosophers and writers published pamphlets showing the advantages and disadvantages of mutual life assurance, and furnished convincing reasons, interspersed with loftiest sentiment, why every one should insure. Here, for instance, is an extract taken from a book published in 1825 by M. J. B. Juvigny, which quite eclipses anything of a similar nature published in this country:—"We have seen that in the private man work adorns existence and strews flowers

on the path of life, but in the citizen it becomes the element of the greatness and power of the nation. Long ago political arithmeticians calculated that if each individual, of both sexes, worked on the average no more than four hours a day at some useful work, this work would suffice to procure all the necessaries and comforts of life; want and misery would be banished from this world once for all, and we could devote the remainder of the twenty-four hours to rest and pleasure. Economists base this statement on very plain reasons, deduced from the theory that earth and water supply the first elements of all our riches. That being so, it is the business of man, as the king of nature, to overcome them by his work. All our ills spring from laziness or the employment of our time on things of little use. Accordingly, to encourage this work, or what is the same thing, to encourage life assurance (since the one is a consequence of the other), is to go to the root of the evil, and to give an impulse to industry, which itself contributes so powerfully to the prosperity of the nation, as one of the necessary elements of its strength and greatness. In fact industry procures and increases ease—ease in its turn encourages marriages, causing them to be contracted at an early age, and thus to be more fruitful, and in consequence increases the population. The State, whose fortune is simply composed of the sum of individual fortunes, finds itself thus richer in money and in men. It is henceforth able to collect the taxes more easily, and to submit with less hardship to the costs and levies that would be necessitated by an occasional war. Life assurance helps also directly to increase the population by encouraging vaccination" (*Coup d'œil sur les Assurances*, J. B. Juvigny, pp. 75 and 76). It is not necessary to quote further to show the philosophical tendency of French insurance literature; when, however, we turn to the practical side of the question we find the people slow to follow the good advice given, and the actuaries themselves calculating and publishing tables of premiums and annuities for perfectly ridiculous ages. Many French writers have ably discussed the advantages of mutual life assurance, and yet to-day the mutual society, in the true sense of the word, is to all intents and purposes non-existent in France. The provident nature of the French people is evidenced in the immense sums of money invested in Annuities with the Government and the Life Assurance Companies, and, on the other hand, their want of foresight may be seen in the mad rush for shares in the Tontine Lafarge, the nature of whose operations will be explained in the historical portion of this paper. M. Louis Pouget, writing many years ago, sums up in a few words the attitude of his countrymen towards life assurance. "From the first," he says, "life assurance in France has had to struggle against the customs of our country.

equal to a fifth of the total capital. The law in regard to mutual societies requires that their statutes must contain a table of classification of risks with the rates applicable to each, etc. The number of contributors (*adhérents*) must be stated, and the minimum of the values insured, before the society can be validly constituted; the sum to account of the contributions of the first year, which must be paid before the constitution of the society, must also be stated. The contributors have, independently of all statutory regulations, the right to withdraw every five years on giving notice to the society six months in advance. A similar right of withdrawal is granted to the society. The regulations in regard to mutual societies were drawn up with the special intention of controlling Mutual fire insurance societies, although they were extended to cover all other kinds of insurance, including life. This, of course, explains the classification of risks and the compulsory membership for five years.

M. Alfred Thomerau in a pamphlet entitled *Quelles sont les Limites de l'Intervention de l'État en Matière d'Assurances?* says: "The State has several ways of intervening in the matter of assurances:—

"(1) It can confine itself to authorising the Societies and imposing upon them certain methods of working and certain limits.

"(2) It can constitute itself the controller of the Societies, and consequently be, or appear to be, the guarantor of their operations.

"(3) Lastly, it can assure on its own account.

"These three methods of government intervention have been practised in France in the course of this century; all three have given bad results."

He then proceeds to show conclusively, from illustrations, how the State has failed, and concludes that "if assurance has made great progress, it is without the State and almost in spite of it; in spite of the disdain which the State has always shown towards it; in spite of the taxes which it has adversely laid on it." These remarks of M. Thomerau refer to insurance of all kinds, Fire, Life, etc., but he reserves for the last and most important part of his article the relation of the State towards Life Assurance. He says: "It is a generally accepted principle, that it is necessary for the State to intervene in this matter; but how and to what extent? This weighty question has given rise to continual controversy for more than twenty years among the ablest writers on insurance. The law of 24th July 1867, article 66, declares that: 'Life assurance societies, whether mutual or proprietary, remain subject to

append to their annual statements of accounts, are nine in number, viz. :—

(A) Profit and loss account.

(B) Financial accounts relative to the various classes of assurance, to life interests, and to reversions.

(C) Balance-sheet.

(D) Statement of the present value of the assets, heritable and movable, contained in the balance-sheet.

(E) Reserves for risks in force at 31st December.

(F) Reserves corresponding to the reassurances ceded to various companies.

(G) Movement of policies, sums assured, and annuities during the year.

(H) Movement of sums assured, and annuities during the year, less reassurances.

(J) Summary statement of the deaths during the year.

These forms, which are much more elaborate than those required by the Act of 1870 in this country, must be filled up annually, and this consequently necessitates annual valuations. Many of the questions contained in the 5th and 6th schedules of the 1870 Act are quite unnecessary in France; for instance, the rates of premium are the same for all companies as well as the valuation rate of interest, the mortality tables and the valuation premiums. On glancing over the schedules, which are printed in the journal of the French Institute of Actuaries (*Bulletin de l'Institut des Actuaires Français*, vol. iv. pp. 30-45), we come on one or two points which call for remark or explanation. In the first place, no revenue account similar to that contained in the first schedule of the English Act is required, although most of the necessary materials to form one may be found in model (B). The two principal accounts are the profit and loss account and the balance-sheet; most of the other accounts are treated as subsidiary accounts, and are styled *annexes* to one or other of these two. On the debit side of the profit and loss account there is entered *portion of interests applicable to the various classes of assurances*, and on the credit side of annexe B, *balance of interests applicable to the various classes* (*rate per cent.*). Those entries are necessitated by the contract entered into by the companies to accumulate the premiums paid at a fixed rate of interest, 4 per cent. on policies issued prior to 1894, and 3½ per cent. on policies issued at the new rates. The method which the companies employ to give effect to this contract, while it is in some respects advantageous to the "with-profit" policyholders, seems to me to supply no additional security to the "non-profit" policyholders—they are, in fact, in no better

position than they would be in if no such contract existed. The method is shortly as follows:—To the reserves at the end of the previous year in any class is added the total premiums received and the interest applicable to that class at 4 per cent. or 3½ per cent., as the case may be; on the other side of the account is placed the total written off during the year, by death, surrender, etc.; the balance is then carried to another account, and after deduction of the valuation reserve, what is left is called the profit for the year, and is divided accordingly.

This method may increase the profits to the "with-profit" policyholders in the event of the company not being able to realise a good rate of interest on its funds; but in the case of the non-profit policyholders the company simply reserves the sums required by the valuation, and the interest profit goes into the pockets of the shareholders. On the credit side of the profit and loss account there is entered: *portion of general expenses and commissions applicable to the various classes of assurances.* The larger proportion of the companies charge the "with-profit" classes with their share of the expenses of management and commission before ascertaining the net amount available for division, of which 50 per cent. goes in bonus to the policyholders. A few of the stronger companies, such as the Générale and Nationale, allow 50 per cent. of the gross profits to the participating policyholders, and charge the shareholders with the whole of the expenses and commission. In a note appended to Table E. it is stated that for policies effected at the new rates the annual premiums of valuation should be entered instead of the actual premiums paid. The valuation premium is the net premium with a loading to cover the expenses of management. (For further particulars in regard to the calculation of valuation premiums see *Office Practice.*) So far as I can ascertain, the valuation of policies effected at the old rates is a gross premium valuation, but by using a table showing a high rate of mortality, the companies set aside what is no doubt a sufficient reserve. On reference to the last annual report of the Générale Company I am confirmed in this opinion, for I find it stated there that in future this Company intends to value the policies effected at the old rates in precisely the same manner as those effected at the new rates. The rate of interest, however, is to remain, as formerly, 4 per cent. A table is embodied in the report showing the reserves calculated according to the old and new methods. The reserves for whole life and survivorship policies amount to £5,041,757 by the old method, and to £5,112,596 by the new method, the necessary increase in the reserve therefore being only £70,839.

On the other hand, the annuity reserves according to the old method exceed those by the new by the large sum of £474,532.

Schedule J. seems to be of little practical use, and might be discarded with advantage and be replaced by tables showing the methods of bonus distribution and minimum surrender values. The schedules appear to have been modelled to a certain extent upon those in use in this country, but, as in America and Switzerland, more minute details are required in regard to investments, especially heritable property.

(4) Investments.

According to the law of 1867, the assurance companies were limited in the investment of their funds to the following:—heritable property, government annuities and treasury bonds, obligations of the Crédit Foncier, and other shares created or guaranteed by the government. The rate of interest at which the premiums were calculated was 4 per cent., and the companies guaranteed to the assured that the premiums paid would be accumulated at this rate. The gradual but constant fall in the rate of interest and the consequent extreme difficulty of employing their funds in a manner sufficiently remunerative, compelled the companies in 1894, with one exception, to reduce the rate of interest which they guaranteed from 4 per cent to 3½ per cent. on all new business. This reduction, however, was found insufficient, and quite recently most of the large companies applied to government and were granted extended powers of investment. In the report of the Union Company for 1897 it is stated that "whilst the premium rates are calculated at 3½ per cent. interest, government securities, railway bonds, and generally the various stocks authorised by the Company's statutes, yield barely 3 per cent. The report continues that "it is necessary to find a remedy as prompt and efficacious as possible for this state of affairs." The company has therefore applied to government for a modification of its statutes relating to the investment of funds. The increased powers of investment consist in the authority to place its funds, to the extent of one-fourth of the paid-up capital and reserves, in French and foreign shares of all kinds, other than those already permitted by the statutes; but the choice of these stocks must be first submitted to a general meeting of shareholders for approval. It is more than likely that all the companies will shortly have received permission to invest their funds in a similar fashion. The following is a list of the shares and bonds approved by the shareholders of the Union for the investment of the Company's funds in accordance with the extended powers of investment:—

Shares of the Bank of France.
Shares and Bonds of Paris Gas Company.
Shares and Bonds of Paris Water Company.

Debentures of the General Omnibus Company, Paris.
Debentures of the General Carriage Company, Paris.
British Government Funds.
Austrian " "
Belgian " "
Chinese 4 per cent. Gold Funds.
Danish Government Funds.
Egyptian " "
Finland " "
Dutch " "
Hungarian " "
Italian " "
Ottoman Guaranteed "
Roumanian Government Funds.
Russian " "
Swedish and Norwegian "
Swiss Federal and Cantonal.
Tabacs de Portugal Bonds.
Suez Canal Shares and Bonds.
Austrian Railway Company's Bonds.
Lombardy " " "

The other companies which have acquired similar powers, such as the Soleil, Générale, and Nationale, have selected, with one or two slight variations, exactly the same funds and stocks.

The following Table II. shows at a glance the various investments of the companies at 31st December 1898, and the percentage of each of the total. For the sake of comparison I have included in the table columns showing the investments of the French companies at 31st December 1884, and of the British Companies at 31st December 1898. It will be noticed that the French companies have at present fully 25 per cent. of their funds invested in heritable property as compared with 7 per cent. in the British companies, and, at the first blush, one is inclined to question the wisdom of locking up such a large sum in investments of this nature. If, however, we inquire more thoroughly into the matter we shall find several good reasons for such a course. In the first place, the law originally prohibited the companies from granting loans on mortgage, and restricted them so much in the investment of their funds that it was necessary to find some means of earning the 4 per cent. guaranteed to the policyholders.

The heritable property, which consists almost entirely of house property in the very best parts of Paris, has from the first yielded more than 5 per cent., and seems likely to continue to be a profitable class of investment to the companies. Considering the losses which the companies in this country have sustained through

the failure of the Australian banks, and more recently in the railway crisis in America, one cannot wonder at the French companies having great confidence that in the future their heritable property, which has yielded them such a good return for more than fifty years, will continue to be a source of profitable investment. The proportion of French government securities has dropped from 18 per cent. in 1884 to 13·4 per cent. in 1898, and it is apparent that the decline is likely to continue, this being the only class of investment showing an actual reduction in amount in 1898 as compared with 1897. On the other hand, the percentage invested in foreign stocks and bonds has risen from 1·5 per cent. in 1884 to 10·7 per cent. in 1898, the increase in the amount for 1898 being fully 10 per cent. of the total previously invested. Within the next few years we may expect to see a rapid increase in the sums invested in such stocks, and, as the French companies become more alive to the advantages of investing a portion of their funds in well-secured British, Colonial, and American securities, they will prove formidable competitors in fields at present almost entirely monopolised by British capital. It is quite impossible to make a detailed comparison of the various items of the investments, but it is worthy of note that heritable property and mortgages combined are in much the same proportion in France as in this country. The proportion of loans on policies is 1 per cent. more in the case of the British companies, but we cannot infer anything from this, as the sums borrowed depend to a large extent on the age and class of business and the surrender values of the policies.

In Table XII. is shown the average rate of interest earned by the companies on their invested funds. The figures in ordinary type are the percentages of interest earned during 1898 to the total funds invested at the end of that year. The figures in italics are an approximation to the real rate of interest earned on the funds, found by deducting one-half of the increase on the reserve fund during the year from the total funds at 31st December 1898, and then calculating the percentage. This was the only course open to me, unless I had written to the whole seventeen companies for their annual reports for 1897. In this connection, I may state that the bulk of my tables have been compiled from the separate accounts of the various companies, as there is no publication in France, so far as I am aware, similar to the *Insurance Blue Book* or *Bourne's Manual* in this country. The average rate of interest earned by all the companies is, according to the first method, 3·8 per cent., and after correction, 3·9 per cent.; the percentage of interest on the mean funds of all the British companies is 3·8 per cent. Such closeness in the rates of interest realised in this country and in France is quite remarkable, and is bound to raise the question in one's

mind as to the wisdom of the French companies in continuing to value their policies with interest tables at 3½ and 4 per cent. They are certainly beginning to realise that these rates are too high, and are, as we have seen, making every effort to increase the returns on their investments. If they continue in this course they are bound to find, what many British companies have already found, that a higher rate of interest generally means an increased risk, and that the losses on investments will, in all likelihood, reduce the average rate earned to the old figure of 3·8 per cent. A reduction in the valuation rate of interest, while it might for a time reduce the profits of the shareholders, would, in the long run, prove advantageous alike to shareholders and policyholders.

(5) Mortality.

It is not my intention to give a detailed account of the many mortality tables published in France during the last hundred years, as the majority of these have been quite discarded by the companies, and are therefore now only interesting from an historical point of view. There are two tables, however, which we cannot pass over without a word or two, for they have formed the basis upon which the annuity and life premium rates of the companies have been calculated from 1819 until 1894, in which year they were superseded by the tables of experience of the companies called Tables R.F. and A.F. The earlier of the two was that of M. Deparcieux, published so far back as 1746. It was the first mortality table published in France, and was constructed from statistics drawn from two sources: (1) from the list of nominees in two French tontines set on foot in 1689 and 1696, supplemented in a very small degree by the short experience of a third tontine, created in 1734; (2) from lists of certain religious persons of either sex belonging to various monasteries and convents in Paris in the early part of the last century. The experience of each of these classes of persons was said to be sufficiently extensive to supply a trustworthy law of mortality. Table No. III. shows the rates of mortality at intervals of ten years from age 20 to 80, by this and other well-known tables. The expectation is greater than that by the Northampton table at all ages except the extreme ages; on the other hand, it is below the Carlisle at all ages and below the Hm. from ages 3 to 37, and greater from age 38 to the extreme ages of life. Comparing Deparcieux's tables with the annuity experience tables, we find that the expectation is greater than by Finlaison's government annuity table (1860) up to age 45, and for higher ages it is less. On comparing it with the Table R.F. (*rentiers français*), compiled from the annuity experience of the French companies, we find that the

expectation is less for all ages: at age 5 it is seven years less; at age 40, two years; at age 50, two years; at age 60, one year; at age 70, one year; and at age 80, half a year. The French companies have been able to distribute large dividends to their shareholders from the annuity business, but it is evident from this that the profit earned has not been from mortality. Deparcieux's table affords no guide to the rate of mortality in France generally, but it is chiefly of interest, as has been said, from the fact that it formed the basis on which the annuity tables of the companies were calculated prior to 1894. The other table to which I have referred is that of M. Duvillard, published in 1806. We have little information as to the source from which M. Duvillard derived his observations, and as to the methods he employed in constructing his table. He states in a note that this table is the result of a considerable number of observations made in different parts of France before the Revolution, and that it is based upon 101,542 deaths at different ages taken in a population of 2,920,672 persons. Until the introduction of the A.F. table, this table, with certain modifications, formed the basis upon which assurances *en cas de décès* were calculated. As will be seen from Table III. it shows too heavy a rate of mortality at practically all ages as compared with the A.F. table. It was thus a very safe table for the companies to adopt for life assurances, and, should the rate of interest fall so low as to compel them to further reduce the valuation rate of interest, a substantial profit from mortality might emerge by using the A.F. table for valuation purposes. The principal tables published since Duvillard's are Demonferrand's (1838), a corrected and revised Duvillard; Hubbard's Friendly Societies (1852); three companies' annuity tables (Générale, Union, and Nationale) (1860); Beauvisage's (1867), formed from the statistics of the Tontine Lafarge; M. de Kertanguy's (1874), based on the experience of the Générale; MM. Achard's and Charlon's (1879), from statistics of the government civil service pensioners; and M. Fontaine's (1887), from the government annuitants. As will be observed, only two of the tables mentioned are constructed from particulars derived from the experience of the companies, viz.: those of the three companies and of M. de Kertanguy; and even in these cases the number of lives was small, and the observations were anterior to the period of the expansion of life assurance business in France. The unsatisfactory nature of the mortality tables in use gradually compelled the companies to bestir themselves, and in 1876 a committee, appointed from six companies, afterwards reduced to four (the Générale, Union, Nationale, Phénix, Paternelle, and Urbaine) decided to construct a mortality table for annuitants, based on observations furnished by these companies, and by the company Le Monde.

The experience covered a period of fifty-eight years from 1819, the year of the foundation of the oldest company, to 1877. Through insufficiency of means the collection and arrangement of the cards was not completed until 1887, in which year it was decided to make an investigation into the mortality amongst assured lives. This was rapidly carried out, and the two tables *rentiers français* (R.F.), annuitants, and *assurés français* (A.F.), assured lives, were roughly adjusted by Woolhouse's formula, and presented at the Paris Exhibition of 1889. The jury awarded a *grand prix* for the work, and each of the actuaries received a gold medal! For the A.F. table the observations were furnished by four companies, and extended from 1819 to 1877. The R.F. table was afterwards completed by the inclusion of observations up to 1889. The two tables were finally adjusted by means of a modification of Makeham's formula and published in 1895, nearly twenty years after the committee was first formed. Tables of premiums and annuity rates were prepared at 3½ per cent. interest, and adopted by the French companies in 1894. The volume contains, in addition to the mortality tables, commutation tables, tables of annuity values upon one, two, three, up to nine lives of equal ages, temporary life annuities for one, two, three, up to ninety-three years, and annuities on two lives for all ages. Not content with calculating these values at one or two rates of interest, the authors have actually calculated them for five rates, 2½, 3, 3¼, 3½, and 4 per cent.; and, being nothing if not thorough, they have made all these calculations separately for each of the two mortality tables. Fancy calculating the value of a temporary annuity for ten years on the life of a child aged 2 years from a table of mortality formed from the data supplied by the annuity business of assurance companies. For completeness the work is truly worthy of a *grand prix*, but the practical utility of many portions of the tables is, to say the least of it, problematical. It is, however, a monument to the perseverance and ingenuity of the French actuaries, and is well worth studying and comparing with works of a similar nature in this country. The principal objection to the mortality tables is that no particulars are supplied from which "select" tables can be formed, the tables published being simply aggregate mortality tables for all ages at entry combined. In the cards on which the experience is tabulated, the companies possess the necessary data from which to construct "select" tables, and it is to be hoped that the actuaries will not rest from their labours until they have completed this most essential work. Another point which is worth noticing is that the graduated tables are based upon the male and female lives combined. So far as the calculation of life premiums is concerned, this is not of great importance as the proportion of females in the table A. F.

is only about one-fifth of the whole; but as regards the annuitants the case is different. In France, as in this country, the mortality among females above 50 is lighter than among males. The consequence is that if we use a combined table and employ the same annuity values for male and female lives, we shall realise a profit from mortality on the males and a loss on the females. If the males and females enter in the same proportion as in our table, we may incur no loss; but if the females increase largely and the males drop off correspondingly, *ceteris paribus*, we are certain to sustain considerable loss. Equity apart, the wisdom of the French offices in adopting a combined table is doubtful, considering the small margin of profit on annuity transactions, and it can hardly be justified even in the event of the sexes continuing to enter in the same proportion as formerly. I would refer those who wish further information on the subject of mortality in France to the published volume of tables which contains an introductory chapter explaining the methods of collection and arrangement of the data and the graduation formulæ employed. A copy of this volume is in the Faculty of Actuaries' Library. An able paper by Mr. G. F. Hardy on the *Mortality Experience of Assured Lives and Annuitants in France*, was read before the Institute of Actuaries in 1897, and is printed in volume XXXIII. of the Journal.

6. Office Practice.

As might have been expected, life assurance business in France is carried on on much the same lines as in this country, the bulk of the assurances effected being either in the whole life or endowment assurance classes. The task of making up a list of the multifarious schemes launched by the British life assurance companies within the last few years would be no light one; while to understand fully the various ramifications, the advantages, benefits, and options entering into these schemes, might tax the powers of a Newton or a Pascal. Happily my task is by no means so onerous; indeed it is a comparatively easy one, as the number of classes into which French life assurance business may be divided is only thirteen. The practice of the French companies is to divide their business into two categories, viz. :—

(1) Assurances en cas de décès.
(2) Assurances en cas de vie.

These divisions are very convenient, although the use of the word assurance, as applied to the latter class, has been taken exception to by an able French legal writer, M. De Montluc, whose book, *Des Assurances sur la vie, dans leur rapport avec les principes du droit*

civil, etc., is in the Faculty Library, and well worth perusal. He condemns very strongly the classing of endowments and life annuities as *assurances en cas de vie*, and praises the English for their correctness in the employment of such terms. We may accept the compliment although it is scarcely deserved; luckily for us, however, M. De Montluc is a Frenchman, and has probably not noticed the periodical bickerings which occur in this country over the correct employment of certain words and phrases. The classes included under the general term of *assurances en cas de décès* are nine in number, viz. :—

(1) Assurances pour la vie entière.	Whole life assurances.
(2) Assurances à primes temporaires.	Limited payment.
(3) Assurances temporaires.	Temporary assurances.
(4) Assurances de survie.	Survivorship do.
(5) Rentes de survie.	Do. annuities.
(6) Assurances Mixtes.	Endowment assurances.
(7) Assurances à capital doublé.	Double endowments.
(8) Assurances à terme fixe.	Under this class the sum assured is payable on a fixed date, whether the assured be alive or not. The premiums cease at the death of the assured should it happen before that date.
(9) Assurances Combinées *or* à effets multiples.	Under this class the sum assured is payable at the death of the assured, if it happen before a fixed date. If the assured survive, he has the choice of three options, viz. :— (1) To remain assured for the full sum, without further payment of premium, and to receive a life annuity equal to the annual premium. 2) To remain assured for the full sum, and to receive immediately a sum down, the amount of which is fixed.

(3) To receive a sum greater than the original sum assured, fixed in advance, the assurance to cease.

Under the heading *assurances en cas de vie* are included :—

(1) Assurances différées sans contre-assurance.	Endowments without return.
Do. avec contre-assurance.	Do. with return.
(2) Assurances dotales.	Endowments on children, premium to cease at death of parent.
(3) Rentes viagères différées.	Deferred life annuities.
(4) Rentes viagères immédiates.	Immediate life annuities.

Practically the whole of the life assurance and annuity business transacted in France may be included under one or other of the various classes mentioned, although several companies, not to be outdone by their American competitors, have started special classes in which, up till now, the business done is quite insignificant. It will be observed that there is only one class which is entirely unknown in this country, viz. *assurances à terme fixe.* This class is intended more especially to meet the case of those who wish to provide a sum sufficient to educate their children or start their sons in business. It is in some respects preferable to the ordinary endowment, as, in the event of the death of, say the eldest son, the amount still remains as a provision for the younger children.

We will now consider what is the practice of the French offices in regard to the calculation of premiums for with and without profit policies. As the whole fabric of insurance business depends upon the correct estimate of the risk to be run by the company, and the calculation of premium rates sufficient to meet that risk together with the expenses incident to the business, it follows that the formulæ upon which these rates have been established are of paramount importance, and must be of peculiar interest to the actuary. In this country, as every one is aware, many of the premium rates charged by even first-class companies have been established on anything but a scientific basis; and, should any luckless Frenchman land on these shores with the intention of discovering how the British actuaries calculate office premiums, one sight of our tables would give him a shock, the evil effects of which nothing but the balmy airs of France could drive away. As has been said in reference to other matters, "they manage these things better in France," for, with the exceptions of the *Caisse Générale des Familles* and *Le Nord*, all the French companies

charge the same rates of premium, the with-profit rates being found by simply making an addition of one-ninth to the non-profit rates. *La Mutuelle Vie* charges the non-profit rates of the other companies, and allows profits to its policyholders after 4 per cent. interest has been paid on the guarantee fund, and an allocation of 15 per cent. of the profits to the subscribers to this fund. The profits of this company have so far been very small, the amount divided amongst the policyholders in 1898 being between three and four thousand pounds altogether. The *Caisse Générale des Familles* charges premiums slightly lower than the other companies, and distributes its profits by way of drawing or lot. Under this system the lucky proprietor of a policy drawn receives a sum in money, calculated according to the age of the life assured at the moment of drawing, and in addition a paid-up policy for the full sum originally insured. This method of distribution is very popular, appealing, as it does, to the inherent cupidity of human nature. The desire to get something for nothing, or at the expense of the insurance company, is as strong in France as in this country, and we accordingly find that whilst the proportion of with-profit to non-profit policies taken with the other companies is steadily declining, the policies *avec tirages* of the *Caisse des Familles* issued in 1898 were nearly four times the number of those *sans tirages*. The chances against a certain policy being drawn in any one year are fully two hundred to one. *Le Nord* is the only remaining company which charges premiums calculated at 4 per cent. interest, its rates of premium being those charged by all the companies prior to 1894, and based on the faulty tables of Deparcieux and Duvillard.

Contrary to the custom generally prevailing in this country, the French companies do not value their policies by the net premium method, but employ a special valuation premium. We have thus three distinct premiums to deal with—the pure premium, the valuation premium, and the office premium. The premiums for whole-life policies without profits are calculated as follows:—

Let A_x = Pure premium—whole life

A'_x = Valuation premium

A''_x = Office premium

Then $A_x = \dfrac{1 - ia_x}{(1+i)^{\frac{1}{2}}}$.

The reason for employing $(1+i)^{\frac{1}{2}}$ instead of $1+i$ is that the French companies all pay claims immediately upon proof of death and title. The rate of interest at which all the premiums are calculated is $3\frac{1}{2}$ per cent., and we therefore have

$$A_x = \frac{1 - \cdot 035 a_x}{(1 \cdot 035)^{\frac{1}{2}}}.$$

The valuation and office premiums are calculated as follows:—

Cost of acquiring business, .	1 per cent. on the sum assured.
Cost of collection, . .	6 per cent. on the premium.
Office expenses, etc., . .	4 per thousand on the sum assured.

Then $A'_x = A_x + \cdot 004 a_x$,

and $A''_x = \dfrac{A'_x + \cdot 01}{\cdot 94}$.

The annual premiums are established thus:—

π_x = pure premium.

π'_x = valuation premium.

P_x = office premium.

$$\pi_x = \frac{A_x}{a_x}.$$

$$\pi'_x = \pi_x + \cdot 004$$

$$P_x = \frac{\pi'_x + \dfrac{\cdot 01}{a_x}}{\cdot 94}.$$

If we compare this formula with Dr. Sprague's, it will be found that with one or two slight differences they are practically identical. Dr. Sprague's formula is:—

$$P_x = 1 \cdot 075 \ (\pi_x + \frac{\cdot 01}{a_x} + \cdot 00125).$$

The French formula is:—

$$P_x = \frac{\pi_x + \cdot 004 + \dfrac{\cdot 01}{a_x}}{\cdot 94}.$$

$$= 1 \cdot 064 \ (\pi_x + \frac{\cdot 01}{a_x} + \cdot 004).$$

On comparing the two formulas we see that the loading for the first year's commission is the same in both cases, but that the percentage for cost of collection of premiums is less in the French case, whilst the constant for office expenses is 8s. per £100 assured in France compared with 2s. 6d. by Dr. Sprague's formula. In the second column of Table IV. will be found the net annual premium by the A.F. table at $3\frac{1}{2}$ per cent. This column has been computed from the Commutation Tables contained in the published Experience Tables to which I have already referred. The tables are in the form adopted by Chisholm, where

$$N_x = D_x + D_{x+1} + \text{etc.},$$

and $P_x = \dfrac{M_x}{N_x}$.

The third column is the Hm $3\frac{1}{2}$ per cent. net premium, and the fourth shows the extra under the A.F. table. The differences at

the young ages are negligible quantities, but they rapidly increase with the age, being 2s. per cent. on the sum assured at age 39, 3s. per cent. at age 44, and 4s. per. cent. at age 48. Column 5 contains the French office premiums taken from the published tables of rates. As a check I calculated one or two values by the formula and found them to work out correctly. Column 6 contains an average British office's premiums, and column 7 shows the extra charged by the French offices. It will be seen that the extra commences at 5s. at age 21, is 6s. at age 26, 7s. at age 33, 8s. at age 37, 9s. at age 42, 10s. at age 45, and 12s. at age 50. In column 8 will be found the loading charged by the French companies. In order to compare this with the loading generally charged by the companies in this country I computed premiums for ages 21, 30, 40, and 50, by Dr. Sprague's formula, employing the tables at the end of the Institute Text Book with 3½ per cent. interest. The office premiums for these ages came out as follows:—

Age 21	1·65	Age 40	2·85
30	2·08	50	4·16

It will be observed that these values agree pretty closely with those of the average company in column 6. The loading at these four ages is:—

Age 21	·29	Age 40	·38
30	·32	50	·48

Comparing this with the loading of the French companies the differences are practically, constant, ·28, ·28, ·27, and ·27, or an addition of fully 5s. per cent. on the sum assured. This is exactly what the manner of loading would lead us to expect, the constant being 8s. per cent. in France, compared with 2s. 6d. per cent. in this country. A reason for this very heavy—one might almost say excessive—charge for expenses of management may be to provide sufficient funds to meet the large dividends which the French companies distribute each year to their shareholders. Reverting to the pure premiums, it is quite apparent that British companies cannot afford to do business in France at the same rates as in this country without injustice to the general body of policyholders. An extra of not less than 3s. per cent. at the young ages, and from 5s. to 7s. 6d. at the more advanced ages, would seem to be necessary. This extra would only provide for the heavier mortality, and would probably need to be increased so as to meet the heavy expenses incident to business transacted in a foreign country. M. Massé, to whom I am indebted for the formula for office premiums, writes that "the formulas become more complicated for certain classes."

Table V. is a comparison of the old rates with the new rates. The extra, according to the new rates, varies from about 3s. per cent. at age 21 to 9s. per cent. at age 50. This considerable increase is, as has been already noted, the primary cause of the heavy drop in the volume of new business in 1894, and it forces the reflection upon us that, if the French companies had loaded their premiums with a constant of 5s. per cent. on the sum assured (double that charged by the British companies) instead of 8s. per cent., the new business would not have experienced the severe check which it has undoubtedly sustained. The balance of profit available for division amongst the shareholders would certainly be reduced, but this would be amply compensated in the increase of business and the ability to compete on more equal terms with the American companies. This view is further confirmed on referring to the dividends paid to shareholders, especially in the case of the large companies. For instance, the Générale, with 750 francs per share paid-up, declared a dividend of 2000 francs per share in 1896, or fully 266 per cent. The dividend has since been reduced to 1000 francs, or 133 per cent. The Phénix pays 1250 francs of dividend on a share of 1000 francs paid-up, or 125 per cent. Instances might be multiplied, but these are sufficient to indicate the immense profits earned by the French companies. In this country the dividends declared by the purely life proprietary companies vary from 5 per cent., or even less, to 35 per cent. in the case of old-established companies.

Table VI. is a comparison of without-profit endowment assurance rates. The extra by the French tables over the British rates is about 3s. at age 21, and gradually increases to 7s. at age 40. The difference is not so great as in the case of whole-life assurances, and this may be partially accounted for in the manner of loading. If, as we may naturally assume, the same system of loading is adopted for endowment assurances as for whole-life, the pure premium being much larger, the percentage for collection will have more influence on the office premium. Remembering that the French companies allow 6 per cent., as compared with the British companies' 7½ per cent., for collection, we see that, as the pure premium increases the excess of loading of the British companies increases proportionately, whilst for both classes of assurance the constants remain the same.

Most complete tables of rates are published by the French companies; in the case of whole-life assurances for every quarter of year of age; in the case of temporary assurances for one, two, three, up to thirty years; in the case of survivorship annuities and assurances for combinations of practically all ages; for life annuities deferred one, two, three, up to seventy years, and for joint-life annuities for all combinations of ages. The tables are

marvellously complete, but the same remark applies to them as to the French mortality experience tables, probably 25 per cent. of the calculations are valueless for all practical purposes. For premiums payable half-yearly and quarterly 2 per cent. and 3 per cent. respectively is added to the annual premiums. These extras represent loss of interest and the risk of losing a portion of the annual premium in the year of death; nothing is added for extra expense in collection. The British companies generally add 5 per cent. in half-yearly and 7½ in quarterly cases, which seem to me rather too heavy increases; on the other hand, 2 per cent. and 3 per cent. are certainly too little.

Commissions.—It is apparent from the manner of loading the premiums that the commissions paid by the French companies must be at practically the same rates as in this country. M. Massé writes to me that "the commissions are from nine to ten per thousand of the sum assured for the first year. For the second, third, fourth, etc., years the companies give what they please, with the condition that the annual commission does not exceed one-half of that for the first year. It would be superfluous to tell you that this rule is often infringed, at least in so far as regards the ten per thousand, particularly in the large towns. Further, under the terms of their appointments special advantages are accorded to certain agents."

Surrender Values.—No surrender value is allowed until at least three entire years' premiums have been paid. Whole-life policies in force for more than three years may be converted into paid-up policies for reduced amounts, or surrendered for a payment of not less than 25 per cent. of the total premiums paid without interest. Similarly endowment assurance and fixed-term policies may, after three years, be converted into paid-up policies, each premium being considered as assuring an integral fraction of the sum assured; these policies are, in fact, non-forfeitable. If three years' premiums have been paid, the surrender-value allowed is the value of the reduced sum assured, discounted for the time remaining to run until the sum assured is payable. No surrender-value is allowed for endowments.

Assignment of Policies.—The assignment of a life policy may be carried out by way of endorsement on the policy itself, or by separate transfer. No assignment of a policy can be validly effected without the written consent of the life assured. In the case where the beneficiary has lost the policy the company is not freed from its obligations by this fact, but is required to deposit the sum assured at the *Caisse des Consignations*, from which the beneficiary is only able to draw it at the end of thirty years from the death of the assured. If, however, immediate payment

of the sum assured is required, sufficient securities must be lodged until the expiry of that period to meet any claim that might arise in the event of the policy turning up. This measure is necessary, as the policies are transmissible by way of endorsement; if the assured had transferred the policy in bad faith, the company might have to pay the assurance twice, whilst by paying at the end of thirty years from the death of the assured, any third party who had possession of the policy would be prescribed. The assignment of a policy by simple endorsement, while considered perfectly valid, has given rise to several cases in which the law courts have decided sometimes in one way and sometimes in another. M. F. Versigny, writing on *Du Droit en Matière d'Assurances sur la Vie*, pp. 18 and 19, says that "according to the circumstances and to the importance of the case it would be wise not to accept a simple endorsement, but to require from the proprietor of the assurance a regular transfer, in conformity with Article 1690 of the Code Napoléon; these formalities, it is true, are somewhat expensive, but they may be avoided by employing another method, which consists in asking from the company, in exchange for the policy, a new policy of which the *clause bénéficiaire* will be agreeable to the wishes of all parties." From what M. Versigny says, it is evident that the assignment of a life policy in France is by no means a simple matter. There is apparently no law requiring intimation to be made to the companies of assignments, and if such transactions were carried out as frequently as in this country, endless litigation would be the inevitable result. The law requiring the written consent of the life assured to every assignation of the policy would be quite unworkable in this country, as it would give the life assured control over the destiny of the sum assured in which his pecuniary interest might be absolutely *nil*.

Reserves.—It is rather difficult to get reliable information on the manner in which the reserves for risks in force are calculated each year. The only English writer, so far as I am aware, who discusses the question is Mr. F. A. Curtis in the *Assurance Magazine* for July 1876. At that time the companies valued the gross premium by a heavy mortality table and 4 per cent. interest. Mr. Curtis quotes from a French writer—M. E. Maas, who says "that the French companies, calculating on the Table of Duvillard, take P'_{x+n} and P'_x, which include their loading, and multiply by the very annuity which has served to establish these premiums; they therefore use the formula

$$(P'_{x+n} - P'_x)(1 + a_{x+n}).$$

As the premiums are not equally loaded, we cannot say *a priori* whether the reserves thus calculated are higher or lower than those deduced from the pure method." He then gives examples

which prove that the French companies, "although their proceedings may be less scientific than those of the English companies, obtain results which are pretty nearly the same, and which afford complete security as well to the assuror as to the assuree." Since the introduction of premium and annuity rates based on the A.F. and R.F. tables the methods of valuation have been altered. In the report of the *Foncière* for 1898, in addition to several other changes in the statutes of the company, is the following with regard to the reserves:—"The reserves must have for minimum value the difference between the value of the engagements undertaken by the assuror and assuree. The values of these engagements should be calculated by means of the *valuation premiums*, and of the pure annuity deduced from the table of mortality and rate of interest adopted in the construction of the tables of rates." In reply to an inquiry M. Massé writes:—"The mathematical reserves are equal to the difference between the engagement of the company and that of the assuree, at the moment of the valuation. These two engagements are calculated with the *valuation premiums, i.e.* the pure premiums increased by the costs of management." From this it would appear that the net premiums, having been increased by a constant, the results arrived at would be identical with those obtained by the net premium method.

Distribution of Profits.—The with-profit rates are formed by simply adding one-ninth to the without-profits, or, in other words, the without-profit are 10 per cent. less than the with-profit rates. The profits are declared annually, and are payable in cash or applied in reduction of premium or increase in the sum assured. Most of the companies allow 50 per cent. (L'Abeille and Foncière 75 per cent.) of the net profits in each class to go to the policyholders in that class. Several of the larger and stronger companies allow 50 per cent. of the gross profits to go to the participating policyholders, and charge the shareholders with the whole of the commission and expenses. The bulk of the business done, as we shall presently see, is in the without-profit classes, and one of the reasons for this is that with yearly distributions the profits vary greatly. If we refer to the report of the Générale for 1898, we find it stated that the mortality had been exceptionally heavy during that year, and the report proceeds further, "that a life assurance company which makes valuations at periods so short as within the space of one year is always liable to fluctuations in the rate of mortality, which cause corresponding variations in the dividends, if it does not take care to reserve a portion of the profits of the years in which the mortality is light to meet the differences in less favourable years." The considerable variations in the profits available for annual division will probably

shortly cause the companies to follow the example set by L'Abeille, which has adopted quinquennial divisions for certain classes.

Annuities.—As has been already indicated, the large tontine annuity business transacted in France in the early years of the century has been diverted into the legitimate channels of ordinary life annuities and endowments. One would naturally expect that the people, having been swindled and deceived so often, would hesitate to invest their savings in annuities of any kind. What is most remarkable, however, is that life annuities are more popular than ever, and that, whilst other branches of assurance business are making steady progress, the annuity business is increasing by leaps and bounds. The old tontine associations, far from being deterrants, seem only to have whetted the appetite of the French people for life annuities, and, now that the evil features of these associations have been eliminated, the companies are well advised to encourage genuine annuity business. The rates charged are based on the R.F. table of mortality, and the security is quite equal to that offered by assurance companies in this country. Table VII. contains a comparison of the rates of annuities of an average British company for male and female lives from age 50 to age 81, and the rates of the French companies for either male or female. It will be observed that at all ages the rates allowed on male lives by the British company are greater than those of the French companies. The difference in annuity at age 50 is 6s. 7d. per annum for every £100 of purchase money. The difference increases steadily up to age 70, and beyond that age very rapidly, until at age 81 it is actually as much as £6, 4s. Turning to the British female rate we find that it is 6s. 2d. less than the French rate at age 50, and that this difference increases up to age 66 when it is 13s., and that after that age it gradually decreases to 2s. 7d. at age 71; from age 72 upwards the British rate is greater, reaching its highest at age 82, when the difference is £5, 11s. Bearing in mind that the rate of mortality according to the R. F. Table is practically identical with that of the English government annuitants table, it is rather curious to find that the French rates should be so much less than the British at the older ages. Under the heading of *Mortality* exception was taken to the French method of allowing equal rates to male and female annuitants—but Table VII. makes it abundantly clear that, even in the extreme case of all annuities purchased being on female lives, the financial position of the companies would not be affected thereby. The dividends to the shareholders would, it is true, be reduced, but the solvency of the companies would never for a moment be in question. Table VIII. is a comparison of the annuity business of the French and British companies. It is not

intended to overstrain these comparisons, the object in most cases being simply to supply a standard by which to estimate the relative values of the figures. For instance, if one were to say that a large annuity business is what the history of the French companies would lead us to expect, and then to state in proof of the extent of the business that the total annuities of the companies in force at the end of 1898 amounted to over three millions sterling, one would not be much impressed by the magnitude of the figures; but if, remembering that there are only seventeen French companies, the statement should be made that their annuity business is nearly three times as great as that of all the British companies, we are able to realise to some extent the significance of the figures. The number of annuity transactions with the French companies during 1898 is almost exactly one-third of the total number of annuities in force with the British companies at the end of that year. The average amount of annuity is £32, as compared with £43 in the British companies. The large influx of working people, who find in the purchase of annuities a convenient method of providing for their old age, has lately caused a considerable drop in the average amount of annuity, which for the new business during 1898 has fallen to £25. The largest amount of annuity permitted by the statutes of the companies to be retained on any single life is £6000 per annum.

There are many other points in *Office Practice* which might have been referred to, but, as they are mostly of minor importance and show only slight deviations from the methods in vogue in this country, and as their study could only be of advantage to those actually engaged in insurance business in France, I do not consider it worth while to bring them under your notice.

Present Position and Prospects.

To form anything like a correct estimate of the present position of the French companies and the direction in which developments may be expected is a matter of no little difficulty. The published literature on the subject is scanty, if indeed it may be said to have any existence at all, and my information is therefore derived almost entirely from the annual statements of accounts of the companies. Tables IX. to XII. have been prepared with the object of showing at a glance the various classes of business and their relative popularity, as well as the channels into which the bulk of the new business may, in the future, be expected to flow. While preparing subsidiary tables containing the details of the total business in force, I was much struck by the fact that such a large proportion of the total business is in the hands of one or two companies. For instance, in annuities, which figure so largely

in the accounts of the French companies, the Générale has on its books fully one-half of the sums payable,—paying annually in immediate annuities the enormous sum of £1,427,933 sterling. If we turn to the other classes of assurance business we find that the Générale, although doing a larger business than any of the other companies, is closely pressed by the Nationale, Phénix, and Union. The probable explanation of this state of affairs is that nearly all the companies charge the same rates, and the public naturally prefer to insure with the stronger companies. This inclination is counteracted to a certain extent in the case of life assurances by the persistent canvassing of agents; on the other hand, annuitants in a great many cases deal direct with the companies, and, looking to security in the first place, choose, rightly or wrongly, the company with largest funds. That companies should all charge the same rates may be a system which has advantages in simplifying matters for the public, but its effect on the companies themselves seems to me to be altogether evil. It paralyses enterprise and ties the hands of the companies in their endeavours to fight the American invaders on anything like equal terms. It has had the further result of driving, as we have just seen, almost the entire business into the hands of a few companies. The smaller companies are making persistent endeavours to combat the evil by expending large sums in the establishment of agencies, and in otherwise pushing their business. As an instance of this *Le Patrimoine*, in justification of its very high rate of expenses (see Table XII.), makes the following statement in its annual report for 1898: "We require to complete our organisation of agencies so as to make the name of the company well known as a life office, and to extend our field of action so as to compete with the other companies, and especially the American companies. Such results can only be obtained at the cost of incessant advances and continuous efforts." Until the smaller companies change, not their methods, but their tables of rates—you may call it actuarial jugglery if you like—they will find themselves always at a disadvantage in the competition for business. The *Caisse des Familles*, with its lottery element, is a striking proof of the advantage of offering special inducements to intending insurers. It is true that, in many cases, people delude themselves into the idea that they are getting something more than full value for their money, but there is really no harm in this provided they receive fair value. The *Caisse des Familles* is the only company which does more business in the with-profit than in the without-profit classes; the reason for this, of course, being the manner in which it distributes its profits. The main purpose in the preparation of Tables IX. to XII. has been to focus, as far as possible, the business

of the companies, and leave the figures to tell their own tale. As an example, let us turn to Table IX., which shows the insurances in force at the end of 1873 with the Générale and Nationale. We find that 83 per cent. in the Générale and 95 per cent. in the Nationale are insurances for the whole of life, and that practically all the business is transacted at with-profit rates. Comparing this with the total business of all the companies at the end of 1898 (Table X.), the percentage of whole-life business has shrunk to 39·21, while the percentage of endowment assurance has gradually crept up to 36·67. Looking now at the new business for 1898 we find that the whole-life business has dropped so low as 25·28 per cent., while endowment assurances have advanced to 46·42 per cent., and endowments account for 16·09 per cent. Of the total business of the British companies, 56·13 per cent. is whole-life and 40·79 per cent. is endowment assurance. The inevitable conclusion to be drawn from the figures is that whole-life assurance is rapidly being superseded by endowment assurance, and, if things continue to move as at present, it is more than likely that the proportions of 1873 for whole-life and endowment assurance will soon be exactly reversed. The proportion of with- to without-profit business has likewise undergone a remarkable change. Of the total business at the end of 1898, 53·36 per cent. is with-profits and 46·64 without; while of new business for that year 18·66 per cent. is with, and 81·34 per cent. without. These proportions are almost identically the opposite of those of the British companies, which are 86·9 per cent. with profits and 13·1 per cent. without. The movement towards endowment assurance is easily understood, as the average Frenchman is always saving for his old age, and, although the tontine annuity system is to all intents and purposes dead, the spirit out of which it sprang is still alive, and asserts its influence in the business of the companies whenever it finds an opportunity. The comparative failure of the "with-profit" business is not so easily accounted for; but it is probably due to the fact that 50 per cent. of the profits is too little to allow to participating policyholders, especially when we bear in mind that proprietary companies in this country can afford to give 90 per cent. The percentage of new premium income to total premium income for the year 1898 is 11·7 as compared with 11·5 in the case of the British companies—a fact which, with a stationary or rather declining population, indicates the vigorous condition of life assurance in France, and gives the companies reason to look forward with confidence to the future. I have prepared Table XI. as a matter of curiosity rather than with the view of supplying additional information to aid us in an estimate of the French companies. It contains a comparison of the average amount of

policy in the various classes of the French and British companies. The average sum assured under each policy with the French companies is £395, compared with £346 with the British companies. This average is steadily increasing, and for the new business of 1898 it is £419. The chief factor in the low average of the British companies is the endowment assurance class, of which the average policy is only £175. One of the tests by means of which we can arrive at a fair estimate of the manner in which a company is conducted, is to find the ratio of commission and expenses of management to premium income, and to compare this rate with an average rate. In Table XII. I have endeavoured to do this for the French companies; but their accounts are prepared in such a way as to make it impossible to discover how much of the expenses is applicable to life business and how much to annuities. It has therefore been necessary to assume certain percentages as applicable to annuity business, and to take the balance as the commission and expenses of the life business. After trying various methods and comparing the expenses in connection with annuity business in this and other countries, the most equitable plan seemed to be to charge the annuity business with 1 per cent. on the purchase price of annuities and 2 per cent. on the total annuities paid during the year. These charges, if anything, err in being too small, and are at the best only an approximation; but they have this merit, that the balances left as applicable to life business are certainly greater than the true amounts. The annual cost per cent. on premium income for all the companies combined comes out at 13·2 as compared with 14·47 in the British companies. It will be noticed that the percentages of the individual companies vary considerably, being as high as 23·1 in the case of the Patrimoine (the reason for this has already been stated), and as low as 8·8 in the case of the Soleil. The four largest companies, however, show fairly close percentages, viz.:—10·5, 12·6, 11·5, and 13·9. To my mind, the outstanding feature of the French business is its remarkable similarity in so many respects to that carried on by the British companies. The rate of interest on invested funds, the percentage of new business to total business, the percentage of commission and expenses of management to premium income, are practically the same in both countries; while the tendency of the business to go increasingly into the endowment assurance classes is even more decided in France than here.

In conclusion, I can only reiterate what I have stated at the outset, that the object of this paper is simply to provide the materials from which each can form his own opinion as to the nature and prospects of life assurance business in France, and the advantages and disadvantages of the various systems in vogue in that country.

I.—TABLE showing the LIFE ASSURANCE and ANNUITY BUSINESS of the FRENCH COMPANIES—1819 to 1898.

YEARS.	Sums Assured.	Annuities.
1819 to 1869 inclusive,	£61,456,000	£1,438,600
1870 to 1879 inclusive,	91,801,800	927,680
1880 to 1889 inclusive,	189,287,440	1,338,880
1890, ...	17,133,880	225,840
1891, ...	17,913,160	236,760
1892, ...	18,942,640	322,280
1893, ...	19,839,840	350,280
1894, ...	11,858,040	259,800
1895, ...	11,295,120	257,600
1896, ...	12,636,920	266,920
1897, ...	13,543,360	308,600
1898, ...	13,962,400	312,000
Totals, . .	£479,670,600	£6,245,240
In force at 31st December 1898,	£143,728,000	£3,019,120

II.—Table showing the Investments of the French Life Assurance Companies as at 31st December 1884, 1897 and 1898.

Class of Investments.	Assets at 31st Dec. 1884.	Assets at 31st Dec. 1897.	Assets at 31st Dec. 1898.	Variation between 1897 and 1898.	Per cent. to total Funds invested at 31st Dec. 1884.	Per cent. to total Funds invested at 31st Dec. 1898.
	£	£	£	£		
Heritable Property,	9,305,279	20,428,784	21,153,717	+ 724,933	25·99	25·27
French Government Securities,	6,450,185	11,484,680	11,293,653	- 191,027	18·02	13·48
Loans to Departments, etc.,	418,255	1,629,117	1,633,328	+ 4,211	1·17	1·96
French Securities Guaranteed,	14,119,094	23,883,500	24,984,398	+1,100,898	39·45	29·84
Various French Securities,	....	1,719,150	1,752,381	+ 33,231	....	2·09
Foreign Stocks and Bonds,	563,359	8,012,682	9,012,086	+ 999,404	1·58	10·77
Mortgages,	992,324	5,237,813	5,392,691	+ 154,878	2·77	6·44
Advances on Policies,	886,925	2,632,262	2,764,589	+ 132,327	2·49	3·30
Life Interests,	606,249	224,106	267,248	+ 43,142	1·69	·32
Reversions,		2,234,961	2,459,320	+ 224,359		2·94
Cash in hand, etc.,	334,836	273,085	281,365	+ 8,280	·94	·34
Premiums due not paid,	....	505,010	517,058	+ 12,048	....	·62
Agents' Balances,	854,485	706,807	760,212	+ 53,405	2·38	·91
Rents and Interests due,	399,843	829,775	876,683	+ 46,908	1·12	1·05
Various Accounts,	859,536	562,238	559,553	- 2,685	2·40	·67
Totals,	35,790,370	80,363,970	83,708,282	+3,344,312	100·	100·

Table showing the Investments of the British Life Assurance Companies as at 31st December 1898.

Class of Investments.	Assets at 31st Dec. 1898.	Per cent. to total Funds invested at 31st Dec. 1898.
	£	
Heritable Property,	18,828,573	7·28
British Government Securities,	4,764,626	1·85
Loans on Rates,	22,968,348	8·89
Indian and Colonial Government Securities,	17,839,031	6·89
Foreign Do.,	7,577,700	2·93
Shares and Stocks,	28,717,297	11·09
Mortgages,	80,649,419	31·15
Advances on Policies,	11,306,750	4·38
Life Interests and Reversions,	5,988,184	2·22
Debentures,	43,542,265	16·83
Cash in hand, etc.,	6,498,909	2·52
Outstanding Interest,	2,374,051	·92
Agents' Balances, etc.,	5,364,900	2·08
Miscellaneous,	2,462,072	·97
Totals,	258,842,720	100·

III.—COMPARISON OF RATES OF MORTALITY by various French and English Tables.

Age.	Deparcieux.	Duvillard.	Carlisle.	H^m.	Assurés Français.	Rentiers Français.	Age.
20	·00983	·01175	·00706	·00572	·00690	·00690	20
30	·01090	·01548	·01010	·00771	·00698	·00664	30
40	·01065	·01891	·01300	·01001	·00975	·00834	40
50	·01721	·02595	·01742	·01572	·01638	·01275	50
60	·02808	·04302	·03349	·02983	·03213	·02411	60
70	·06129	·08148	·05165	·06410	·06897	·05298	70
80	·14407	·16767	·12172	·14426	·15190	·12403	80

IV.—TABLE OF NET ANNUAL PREMIUMS for Assurances for the Whole Term of Life by the A.F. and H^m Tables, with a Comparison of the Office Premiums charged by the French Companies and an average British Company.

Age.	A.F. $3\frac{1}{2}$ % Net Premium 100 π_x.	H^m $3\frac{1}{2}$ % Net Premium 100 π_x.	Extra % on Sum Assured under A.F. Table.	French Companies Without Profit. Office Premium 100 P_x.	British Company Without Profit. Office Premium 100 P_x.	Extra % on Sum Assured. Office Premium.	French Companies Loading $100(P_x-\pi_x)$.	Age.
21	1·38	1·37	·01	1·95	1·70	·25	·57	21
25	1·54	1·52	·02	2·12	1·83	·29	·58	25
30	1·80	1·77	·03	2·40	2·07	·33	·60	30
35	2·14	2·07	·07	2·76	2·38	·38	·62	35
40	2·58	2·47	·11	3·23	2·80	·43	·65	40
45	3·14	2·98	·16	3·84	3·34	·50	·70	45
50	3·89	3·67	·22	4·64	4·04	·60	·75	50

V.—COMPARISON OF THE OFFICE ANNUAL PREMIUMS for Whole-Life Without Profit Assurances charged by the French Companies prior to 1894 (Old Rates) and Rates now charged (New Rates).

Age.	Old Rates.	New Rates.	Increase by New Rates.	Age.
21	1·81	1·95	·14	21
30	2·24	2·40	·16	30
40	2·95	3·24	·28	40
50	4·19	4·64	·45	50

VI.—Comparison of Office Annual Premiums for Endowment Assurances Without Profits charged by the French Companies and an average British Company.

Age.	100 $P_{x:\overline{n}\rceil}$ Age 50.		Extra % on Sum Assured by French Table.	100 $P_{x:\overline{n}\rceil}$ Age 55.		Extra % on Sum Assured by French Table.	100 $P_{x:\overline{n}\rceil}$ Age 60.		Extra % on Sum Assured by French Table.	100 $P_{x:\overline{n}\rceil}$ Age 65.		Extra % on Sum Assured by French Table.	Age.
	French Cos.	British Co.		French Cos.	British Co.		French Cos.	British Co.		French Cos.	British Co.		
21	3·05	2·91	·14	...	...	...	...	...	...	...	...	...	21
25	3·59	3·40	·19	3·00	2·81	·19	...	...	...	...	..	...	25
30	4·63	4·38	·25	3·70	3·46	·24	3·13	2·89	·24	...	...	...	30
35	6·37	6·06	·31	4·75	4·46	·29	3·86	3·57	·29	3·32	3·04	·28	35
40	9·87	9·48	·39	6·52	6·17	·35	4·95	4·61	·34	4·10	3·76	·34	40

VII.—Table showing the Rates of Annuity allowed by the French Life Assurance Companies and an average British Company. Purchase Price 100.

Age.	French Companies, Male and Female.	British Company. Male.	British Company. Female.	A—B.	A—C.	Age.	Age.	French Companies, Male and Female.	British Company. Male.	British Company. Female.	A—B.	A—C.	Age.
	(A)	(B)	(C)					(A)	(B)	(C)			
50	6·47	6·80	6·16	− ·33	+ ·31	50	71	12·34	13·35	12·21	− 1·01	+ ·13	71
55	7·32	7·65	6·93	− ·33	+ ·39	55	72	12·67	13·95	12·76	− 1·28	− ·09	72
60	8·49	8·90	8·02	− ·41	+ ·47	60	75	13·54	15·94	14·60	− 2·40	− 1·06	75
65	10·14	10·55	9·51	− ·41	+ ·63	65	80	14·63	20·12	18·63	− 5·49	− 4·00	80
66	10·53	10·95	9·88	− ·42	+ ·65	66	81	14·79	21·00	19·55	− 6·21	− 4·76	81
70	12·01	12·79	11·71	− ·78	+ ·30	70							

VIII.—Comparison of the Annuity Business of the French and British Assurance Companies as at 31st December 1898.

Class of Annuity.	British Companies. Total Business.			French Companies. New Business, 1898.			French Companies. Total Business.		
	Number of Bonds.	Amount of Annuities.	Average Amount of Annuity.	Number of Bonds.	Amount of Annuities.	Average Amount of Annuity.	Number of Bonds.	Amount of Annuities.	Average Amount of Annuity.
Deferred, .	9,755	£268,995	£27	817	£18,552	£22	4,786	£232,542	£48
Survivorship,	..	..	..	112	3,712	33	1,226	39,270	32
Immediate, .	27,436	1,355,041	49	11,538	291,563	25	92,084	2,842,851	31
	37,191	£1,624,036	£43	12,467	£313,827	£25	98,096	£3,114,663	£32

IX.—Assurances in force at 31st December 1873 with the Générale and Nationale Companies.

Class of Insurance.	Générale.	%	Nationale.	%
Whole Life, ...	£11,750,832	83·4	£10,855,500	95·3
Endowment Assurance, .	1,678,222	11·9	234,058	2·1
Term Certain, ...	247,146	1·8	64,505	·6
Temporary and Contre, .	113,167	·8	90,761	·8
Survivorship, ...	11,840	·1	.....	...
Endowments, ...	277,601	2·0	138,921	1·2
Total, .	£14,078,808		£11,383,745	

Of the above Whole-Life Assurances the sums of £234,919 in the Générale and £196,651 in the Nationale are without profits.

X.—COMPARISON of percentages of the principal classes of Assurance Business of the French and British Assurance Companies as at 31st December 1898.

Classes.	British Companies. Total Business.				French Companies. New Business, 1898.				French Companies. Total Business.			
	Percentage of Policies in various classes.	Percentage combined With and Without Profits.	Percentage of Policies With Profits.	Percentage of Policies Without Profits.	Percentage of Policies in various classes.	Percentage combined With and Without Profits.	Percentage of Policies With Profits.	Percentage of Policies Without Profits.	Percentage of Policies in various classes.	Percentage combined With and Without Profits.	Percentage of Policies With Profits.	Percentage of Policies Without Profits.
Whole-Life With Profits,	47·55	56·13			3·44	25·28			23·34	39·21		
Do. Without Profits,	8·58				21·84				15·87			
Endowment Assurance With Profits,	38·17	40·79			9·93	46·42			17·73	36·67		
Endowment Assurance Without Profits,	2·62				36·49				18·94			
Endowments With Profits,	·12	1·13	86·90	13·10	16·09	16·09	18·66	81·34	6·29	6·29	53·36	46·64
Do. Without Profits,	1·01											
Joint-Life, etc., With Profits,	1·05	1·95			...	...			...	...		
Do. Without Profits,	·90				...	...			...	...		
Fixed Term With Profits,	...	...			·91	4·80			7·17	14·51		
Do. Without Profits,	...	...			3·89				7·34			
Combined,	...	...			4·65	7·41			1·71	3·32		
Temporary, Contre, etc.,	...	...			2·76				1·61			

XI.—COMPARISON of the average sum assured under various classes of assurance with the French and British Life Assurance Companies.

	British Ordinary Companies.				French Companies.							
	Total Business in force at 31st December 1898.				Total Business in force at 31st December 1898, less Re-assurances.				New Business for Year 1898, less Re-assurances.			
Class.	Number of Policies.	Sums Assured.	Average Amount of Policy.	Average Amount of Policy after deducting Re-assurances.	Number of Policies.	Sums Assured.	Average Amount of Policy.	Average Amount of Policy (Combined).	Number of Policies.	Sums Assured.	Average Amount of Policy.	Average Amount of Policy (Combined).
Whole Life—With	807,447	£394,255,703	£488	£462	81,383	£35,783,096	£439	£416	988	£403,742	£408	£475
Whole Life—Without	145,653	71,674,338	492		55,342	21,094,500	381		6,265	3,044,142	485	
E.A.—With	648,169	109,338,088	169	175	61,824	24,872,482	402	383	2,848	1,098,426	385	406
E.A.—Without	44,483	13,950,587	313		66,061	24,200,049	366		10,468	4,314,751	412	
Endowment—With	2,034	424,039	208	238	...	...	...	...	...	...	...	...
Endowment—Without	17,134	4,153,850	242		21,933	6,070,790	276	...	4,615	1 564,836	339	...
Joint Life, etc.—With	17,852	5,128,999	287	629	...	...	...	...	...	...	...	...
Joint Life, etc.—Without	15,271	20,830,392	1364		...	...	...	...	...	...	...	...
Fixed Term—With	...	...	...	...	25,000	11,252,121	450	427	260	97,421	374	444
Fixed Term—Without	...	...	...	...	25,597	10,381,169	405		1,117	514,351	460	
Combinées	...	...	...	...	5,981	2,909,990	486	...	1,333	723,299	542	...
Temporary, etc.	...	...	...	...	5,602	1,477,966	264	...	793	267,780	337	...
	1,698,043	£619,755,996	£365	£346	348,723	£138,042,163	£395	...	28,687	£12,028,748	£419	...

XII.—STATEMENT showing the percentage of COMMISSION EXPENSES OF MANAGEMENT to Premium Income an AVERAGE RATE OF INTEREST earned on the Fun the French Life Assurance Companies. Year 1898.

Name of Company.	Annual Cost per cent. on Premium Income.	Average ra Interest e on Fund
Générale,	10·5	3·83 3·91
Union,	12·6	3·68 3·75
Nationale,	11·5	3·90 3·98
Phénix,	13·9	3·79 3·87
Caisse Paternelle,	14·5	3·81 3·89
Urbaine,	19·3	4·08 4·16
Caisse des Familles,	11·8	4·06 4·14
Monde,	18·7	3·84 3·92
Soleil,	8·8	3·77 3·85
Aigle,	16·6	3·70 3·77
Confiance,	14·5	3·81 3·89
Patrimoine,	23·1	4·51 [1] 4·60
Abeille,	14·3	3·55 3·62
France,	12·1	3·75 3·83
Foncière	14·2	3·64 3·71
Nord,	13·3	3·49 3·57
Providence,	12·9	3·19 3·25
All French Companies,	13·2	3·82 3·90

[1] The high rate of interest in this case is caused by a large profit on Life Interests Reversions.

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Life Office Investment—1850 *to* 1900

BEING

THE INAUGURAL ADDRESS FOR
SESSION 1900-1901

BY

A^W H. TURNBULL, F.F.A., F.I.A., F.R.S.E.

MANAGER AND ACTUARY, SCOTTISH WIDOWS' FUND AND LIFE ASSURANCE SOCIETY

HONORARY PRESIDENT OF THE SOCIETY

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Life Office Investment—1850 *to* 1900.

GENTLEMEN,—When you did me the honour to appoint me your President, and gave me for the fourth time the privilege of addressing you from this chair, I was within a few weeks of completing the fiftieth year of my business life, and my thoughts dwelt much upon the changes I had seen in that time.

Such being the case, you will not be surprised that I decided to offer you a retrospect of some one important branch of our business. I selected Life Office Investment, of which I think I can claim to have had an unusually long and varied experience.

In the treatment of my subject I shall endeavour to confine myself to a narration of such facts, and to draw such inferences from them, as I can reasonably hope will interest and instruct the younger members of the Society, and which, at the same time, will serve to remind their seniors of the steps by which our present notions of what is safe and advisable in the investment of the funds of a Life Assurance Office have been arrived at.

As the extent and condition of the fields in which investments have been sought have an important relation to my subject, I must ask you to bear with me while I contrast what these were in 1850 with what they are now, particularly in respect of population and wealth.

The United Kingdom is the principal of these fields. Its population, about twenty-seven and a half millions in 1850, is now estimated at fully forty-one millions, an increase of 50 per cent. Indeed, the increase in Great Britain has been more than 50 per cent., as the population of Ireland, which was six and a half millions in 1850, has fallen by two millions. Then as to Wealth, or Capital, Giffen estimated it at £8,500,000,000 in 1875, and showed that it had increased by £2,400,000,000 (or 240 millions per annum) in the previous ten years. In 1885, using data similar to what he had used before, he estimated it at £10,000,000,000, showing an increase of £1,500,000,000 (or 150 millions per annum) in the ten years. Following Giffen's method, but *very* roughly, I now estimate it at £11,000,000,000, showing an increase of £1,000,000,000 (or 67 millions per annum) in the fifteen years.

The Capital of the United Kingdom I believe to have been le than £5,000,000,000 in 1850,[1] consequently it has increased i the interval by fully 120 per cent. The amount of it per hea of the population in 1850 was from £170 to £180. If m estimate of present Capital is nearly correct—I believe that wrong it is an underestimate—it is now equal to from £260 t £270, or fully 50 per cent. more, per head, than it was in 185 Looking to the improvement in the general style of living whic I have witnessed in these years, due in part to increase in th emoluments of workers, and in part to the cheapening of man necessaries and luxuries, I have no hesitation in saying that far larger proportion of the forty-one millions of population ar in a position to avail themselves of life assurance and thereby t give us funds for investment, than was the case with the twenty seven and a half millions fifty years ago, while their work ha enormously increased the home field of investment, and—wha from our point of view is not so agreeable—has added largely t the number of Capitalists, and of Trust Estates, to compete wit us for the best of them.

The Government of India was in the hands of the East Indi Company in 1850, and remained so until the autumn of 1858, b which time the Mutiny, which broke out in 1857, was nearl suppressed. There were no railways in that country until 1853 and no Suez Canal until 1869, and though, as the outcome of th persistent efforts of one man, Lieutenant Thomas Waghorn, wh was rather thwarted than encouraged by those who had most t gain by his success, there was land transport across the Isthmu of Suez in connection with steamships touching at Alexandria an Suez, yet the bulk of the traffic to India still went round the Cape.

In South Africa the Orange Free States had not come int existence. The Transvaal, founded two years previously, was no declared independent until two years later, and the originator o the project of a Cape to Cairo Railway was not born. The Cap Colony and Natal were known to be healthy, indeed were to som extent health resorts, but they were more or less unsettled, an danger then, and until much later, occasionally arose from th preponderance of natives. The Sahara was supposed to cove nearly the whole interior of the continent, and the British settlements on the West Coast were well known to be, for Europeans among the most unhealthy places in the world.

In Australia, the best known parts of which were occupied a convict settlements, the free settlers were few in number, and i

[1] 'The wealth of the people (of *Europe*) all told, which would probably not have been reckoned at more than 5,000,000,000 at the beginning of the century, must be reckoned now by tens of thousands of millions.'—*Sir Robert Giffen, Manchester, 17th Oct.* 1900.

was generally believed that all but the fringe of the continent was a Desert. The discovery of gold early in 1851 increased the elements of disorder and the risks to residents, particularly to those who engaged in gold-searching. There was little wealth there in 1850. Now, though the population is small for such a vast country, the wealth per head is comparatively large—and so are the public debts—yet such is the credit of the Australian Colonies in the British money market that they borrow on remarkably easy terms, while of late the Owners of real property have had no difficulty in obtaining advances on it at as low rates as are current in England.

New Zealand was a promising Colony, not until years after disturbed by native wars, but the European population was, and still is, comparatively small. It is now financially in almost as good a position as Australia, and in the matter of climate is preferable.

In North America—in which I include both Canada and the United States—the settled population was to be found almost exclusively well to the east of the Mississippi and the Great Lakes. There was a very *unsettled* population in California, drawn there by the discovery of gold in 1847, and the British settlements on Vancouver's Island and the mainland adjoining were little known. The population of the United States in 1850 was 23,192,000, of which some 3,085,000, or 13·3 per cent., was coloured; it is now estimated to be 78,300,000—three and a third times as large—including nine millions, or 11·5 per cent., coloured. The wealth per head was estimated at £60; it is now estimated at over £200, but the distribution is very unequal.[1]

The position of States on the Continent of Europe has changed much in the fifty years, principally as regards Germany, Italy, and France. Few, if any, British offices sought investments in them till recently, but their governments are all now in fair credit financially, the municipalities of some of them find a ready market in this country for their bonds, and Continental loan agents tell me that they have customers for Mortgages on Real Estate among British Life Offices.

China was little known beyond the British settlements, and was certainly not a field for investment, and Japan was a *terra incognita*, foreigners being rigidly excluded until 1853. Now each of these countries has a National Debt of its own, held in part by Life Assurance Offices, and, according to the *Boston Standard*, Japan has seventy-three Life Offices; it has also an Institute of Actuaries,

[1] The Democratic party some years ago asserted that Protection—to which they are opposed—has 'concentrated one-half of the wealth of the great Republic in the hands of 17,000 individuals, and handed over to 250 capitalists one-twelfth of the total assets of 63 millions of citizens.'

representatives of which are to be met with at meetings of the International Congress.

So much for the fields in which Life Offices seek investments. What I have said of them will bring home to you the change which, during the last fifty years, has come over the world, and in particular over those parts of it inhabited or governed by an English-speaking race.[1] Districts, accounts of which we have within that time received from their *first* explorers, whose experience of dangers, difficulties, and privations formed not the least interesting part of their narratives, are now studded with homes of the white man and covered with his work. Many hundreds of thousands of square miles have been added to his heritage, and now have a value they never had before, a value which increases with every year of his presence.

It has fallen to my lot of recent years to visit some of the new places of the earth, and nothing interested and astonished me so much as to find law, order, comfort, many luxuries, and many signs of increasing wealth in the once dreaded Bush of Australia and Tasmania, and in the once lonely, but Indian-haunted prairies, and the sites of old mining-camps, in America—all brought about in comparatively few years.

An increase of population in our own old land, and the same combined with the acquisition of new land in America and Australia, has been accompanied by an enormous increase of national wealth, much of which may be classed as 'unearned increment,' a kind of wealth which in my opinion fluctuates more in value, in new countries at least, than wealth derived from 'accumulated labour'—the old definition of Capital.

The value attached to Town sites and to Buildings in new countries in many cases exceeds the value attaching to them in cities of greater size and importance in this country; to the land, usually from some fancied difficulty in the way of extension; to the Buildings, in consequence of the cost of labour, which will almost certainly fall with an increase of the Artisan population—considerations to be borne in mind by any who are tempted to buy, or to lend upon, House property in New Countries.

In this connection I may tell you that in America, where the

[1] A writer in the *Times* a few years ago estimated that of people speaking European languages at the beginning of this century, 19·6 per cent. (31,000,000) spoke French, 18·4 per cent. (30,000,000) spoke German, and barely 13 per cent. (21,000,000) spoke English, while at the time he wrote 31 per cent. spoke English—twice as many as spoke any other European language. Speaking at Manchester, 17th October, Sir Robert Giffen estimated the population of the United States with those of the United Kingdom and her self-governing Colonies at 135,000,000. A fraction of these, as in Canada, do not speak English, but on the other hand there are many English-speaking in our Crown Colonies and Dependencies.

Tramways are all, or nearly all, in the hands of private companies, they run so far beyond the City Boundaries, at such low fares, that in several places, where the inhabitants desire fresh air, and light taxation, the residential portions are falling in value, the demand for town sites for business purposes not being able to keep pace with the exodus. Has dread of this anything to do with the desire manifested by British City fathers to acquire and control our Tramway Systems?

An increase of population and a reclamation of waste lands are not the only factors which have contributed to the World's wealth and influenced investment during the last fifty years. Of many others, perhaps the two most outstanding are the enormous additions to the World stock of above-ground gold, and—at least as far as this country is concerned—the introduction of limited liability.

In the early fifties the Gold discoveries made in California in 1848, and in Australia in 1851, gave rise to much discussion as to the probable effect on prices, and on debts, of the great increase in the commodity by which they were measured, in the few countries then having a Gold Standard. Between 1850 and 1870 the output is said to have been of the value of from 30 to 40 millions sterling annually. It fell off subsequently owing to the exhaustion of placer deposits, but has risen again since the discovery of gold in South Africa, Klondyke, and Western Australia, and the opening of rich mines elsewhere.

As the gold produce of the world before 1848 did not exceed five millions sterling per annum, a fear that the value of gold as compared with that of other commodities, and consequently its purchasing power, *must* decrease, was very generally entertained by persons interested in deferred payments. 'The value of money is inversely as general prices, falling as they rise and rising as they fall.' In other words, gold being our standard money, a depreciation of it is the same thing as an appreciation or general rise in prices and *vice versa*. Prices did go up for several years, but there were other influences at work than increased production of gold: there was the demonetisation of it by Spain, Portugal, and Holland, which threw coin to the value of nearly nine millions and a half on Paris in 1850-51; there was the Crimean War, and the Indian Mutiny later, and then the Civil War in America: it was not until 1879 that, as compared with gold, prices fell so low as they had been in 1850. Nevertheless there were not wanting financiers who held that the effect of the discoveries would be counterbalanced in some way, and that any disturbance caused by them could be but temporary. Newmarch, a Statistician, Actuary, and Banker, who is probably best

known as having assisted Tooke in the preparation of his two last and most famous volumes on prices—those covering the years from 1848 to 1856 inclusive—took this view. As early as 1850 he wrote, 'There seems to be no authority for expecting that, under contracts now existing, creditors will be sacrificed to debtors; that the recipients of fixed incomes will be hopelessly impoverished; or that capital will cease to command a reasonable rate of interest,'—and gave his reasons. Measured by a standard he himself may be said to have invented, and which to this day has been continued by the *Economist*, his forecast as regards prices was remarkably correct. There have been many ups and downs caused by events quite outside the production of gold, but, as shown by the *Economist* 'index numbers,' derived from the prices of 1899, the purchasing power of a sovereign was then if anything a little more than it was at the time Newmarch wrote. Whether his forecast regarding interest was as correct, depends upon the view he took of what could be considered a *reasonable* rate. It was the recipients of *fixed* incomes that he endeavoured to reassure, not those of incomes derived from interest.

How is it that the prices of commodities have been so little affected by the increase in the supply of gold, an increase which, if Mulhall's estimate of 1885 is correct, must now have brought the total supply of gold above ground up to four times what it was in 1850?

Much has been taken up by other large nations adopting a gold standard of currency, and much by the increased demand by all nations using it as money caused by the requirements of an ever-extending Trade, but it is thought that the chief factor has been the cheapening of production of other commodities and of carriage.

I dare say few of you have seen a field of standing grain cut with a sickle and thrashed out with flails on a barn floor, but such processes were common in 1850 and for years after—you can judge at what a cost of labour. The introduction and gradual improvement of reaping-machines, of steam-thrashing machines, of steam-ploughs, and of other labour-saving agricultural implements, has reduced the cost of the cultivation of grain at home, and at the same time has enabled the sparse population of our Colonies, and of districts of the United States, to cultivate large tracts of land which might otherwise have been left uncultivated for years to come. This, coupled with cheaper carriage by land and sea, has kept down the price of that principal form of produce, and where improved methods of cultivation and harvesting have not kept down the price of other produce, as in the case of raw cotton, which has risen, improved machinery has reduced the cost of clothes manufactured from it.

Then the teachings of Science have enabled us to make more

than formerly of our Iron ore, and other mineral substances and dye-stuffs, besides enabling us to supply ourselves with such 'produce' as butter, which never came from milk, and egg powders, that were never inside a shell, while machinery of a labour-saving and constantly improving kind is now employed in almost every manufacture, from the building and arming of a line-of-battle ship to the making of the parts of a Waterbury watch.

Compared with 1850, five or six times as much steam power is now used. We have three times as many miles of railway in this country, and at least twelve times as many in the world, including railways in India and Australasia, where there were none, and in Canada where there were only some 400 to 500 miles.

Where railways can be used, land carriage is reduced to one-sixth of what it was, and the steamship of to-day carries in a year five times as much merchandise as the sailing ship of equal tonnage then more generally used.

Except in the case of some few companies to which limited liability had been given by Royal Charter, Letters Patent, or Act of Parliament, the shareholders of Joint Stock Companies were, until 1855, liable for the debts of the company to their last shilling. In August 1855 an Act was passed (18-19 Vic. c. 133) 'for limiting the liability of members of certain Joint Stock Companies,' but it did not extend to Scotland, a disability which was removed in the following year by 'The Joint Stock Companies Act, 1856' (19-20 Vic. c. 47) applicable to the whole country. Banks were excluded from the privilege until 1858, and those in Scotland did not take advantage of it until after the failure of the City of Glasgow Bank in 1878.

Ability to form Joint Stock Companies with limited liability has had the effect of greatly increasing the number of Companies not only in this country, but in such of our Colonies and such foreign countries as have adopted the principle and, as a large proportion of these companies take up money on loan, their obligations offer a large and ever-extending field for investment, but one which has to be cultivated with great caution.

Since 1850 great changes have taken place in the views entertained by the Directors and Officials of Life Assurance Offices as to the investments suitable for funds in their charge.

In the Office with which I am now connected, the Directors of which fifty years ago invested in much the same securities as the Directors of other Scotch Offices I have knowledge of, nearly four-fifths of the Funds were lent upon security of land, or of interests in land, *in Scotland*, the remainder being lent to policyholders on security of their policies, and to Railway Companies on Debenture;

or invested in the purchase of Government Annuities, and of Stocks of the Bank of England and the three chartered Scotch Banks. Some Scotch Offices made advances on land in England, and some on land in Ireland, but the security was not considered so perfect as that of Scotland, owing to the absence of a complete system of Registration, and an extra rate of interest was looked for and in those days obtained.

Among loans on land, loans under the 'Private Money Drainage Act,' passed in 1849, were beginning to appear, but little was done in that way until the business was taken up, and preliminaries carried through, by the Drainage and Improvement Companies, the first of which also came into existence in 1849. For many years these loans were a favourite form of investment with Assurance Offices, and one for which few other capitalists cared to compete. They are now either much rarer than they were, or they are disposed of at rates too low for the Assurance market.

Among loans on interests in land were loans to heirs of entail in possession, which then usually took the form of a Bond of Redeemable Annuity, now seldom if ever heard of. Messrs. Law and Irvine, in their *Law of Rights in Security Heritable and Moveable* (1897), state that this system of borrowing upon Annuity was devised to evade the Usury Laws. The borrower sold an annuity to the lender at a certain price, reserving a power of redemption at the same price, which was practically the amount of the advance,—Policies of Assurance to the amount of the price, or advance, were effected by the lender on the life of the borrower, and the borrower's life interest was assigned in security of the Annuity, which was for an amount sufficient to cover interest on the sum paid (or advanced) as well as the premiums for assurance. This form of security brought the Offices transacting it large assurances of a class we now see little of in Scotland, the Rutherford Act of 1848, followed by extending Acts of 1875-1882, having put it in the power of Heirs of Entail in possession, at first with consents, and latterly without consents, but on payment, or consignment, of compensation, to borrow upon the fee of the estate, dispensing with Life Assurance. Under the Bond of Redeemable Annuity the obligant was bound to pay the Annuity, and could redeem it at pleasure, *but was under no obligation to do so.*

I understand that the Bond taken from a borrower on life interest since the repeal of the usury laws is much like other Bonds, *requiring payment of the principal when called for*, when, of course, on repayment the security, consisting of a charge on the life interest for premiums of assurance and for a higher rate of interest than it is intended to exact—except on default—and the policies would be given up.

The Bond of Redeemable Annuity was by no means the only

form of security 'devised to evade the Usury Law.' According to Professor Nicholson,[1] Walter Ross, in the introduction to his *Lectures on the Laws of Scotland* (1793), shows that 'to the devices fallen upon to defeat these Laws the greatest part of the Deeds' then 'in use both in England and Scotland owe their original forms.'

With a modification in 1839, continued in 1850, exempting certain bills of exchange and promissory notes from their operation, these Laws—which were continued in force down to August 1854—had in Great Britain, from the time of Queen Anne (1713) to that date, made a charge of more than 5 per cent. illegal. Before Queen Anne's time—and I understand that in Ireland even after her time—the legal rate was higher.[2]

Although attempts to regulate the charges of money-lenders have for centuries been made and failed, that apparently does not discourage the legislator of the present day. This very day (1st November 1900) an Act to regulate money-lenders came into operation which will increase the risks of the business, and as an almost certain consequence the cost of accommodation to such needy borrowers as object to the publicity attending an application to a court for relief.

In Ireland many estates were thrown on the market after the famine of 1848, most of them heavily encumbered, and owing to the difficulty in making up titles few capitalists could be found to purchase or to make advances upon them. Between 1849 and 1850 Acts of Parliament were passed under which a Court, known as the Encumbered Estates Court, afterwards superseded by the Landed Estates Court, granted titles freed from old encumbrances, which greatly encouraged dealings in Irish land and induced many capitalists—Assurance Offices amongst others—to make advances on security of it. From the point of view of a mortgagee, or a mortgagee's Irish adviser, the security was considered perfect, particularly for loans in those parts of Ireland where tenants had by usage a pecuniary interest in the land—a tenant-right—sometimes of larger amount than the landlord's interest, which was very naturally regarded as something like a ground rent backed by the tenant's interest. However, when the remarkable Land Laws of 1881 onwards came into operation, it was found that the landlord's interest could be, and very generally was, cut down, and that the tenant really had the first charge on the property for his tenant-right—an interest now legally recognised in all parts of Ireland.

[1] *Encyclopædia Britannica—Article, Usury.*

[2] 'It was not until 1887 that the last provision against usury—a provision limiting the rate of interest in the East Indies to 12 per cent.—was removed from the Statute Book.'—*Scotsman*, 23rd October 1900.

Land legislation for Ireland during the last twenty years, with the uncertainty of what further legislation may be in store, has driven much Life Assurance Capital out of that country, and I rather wonder that Assurances Offices still make advances there. For that matter I am surprised that so much is still lent upon landed property in Great Britain, on easier terms than were common before such enactments, as it is by no means improbable that the relation between landlord and tenant may be interfered with on other estates than those in Ireland, or in the crofter districts of Scotland. The holding of real estate is not now a necessary qualification for a seat in Parliament, and the landlord's interest is less and less represented there.

The Government Annuities referred to as among the investments of fifty years ago, were annuities on lives sold by the government of the day for the purpose of raising money under the provisions of an Act of the Parliament of 1830 (10 Geo. IV. c. 24). The purchasers were allowed to select the lives, and these at the outset might be of any age over 15. In March 1834 the Commissioners of the National Debt gave notice that they would not grant annuities on the lives of nominees over 65, and that was probably the age of lives on which most of the annuities held by Life Assurance Offices were purchased. They continued to invest in this way up to 1852. The country was searched for hale old men with family histories showing longevity—budding centenarians—and it is understood that very considerable profits were made by the purchasers.

There was considerable difficulty in proving the ages of the nominees, and it is not to be wondered at that some errors occurred, principally due, I believe, to parents, intent on preserving a name in their family, giving it to a second son when the first to bear it died in infancy. Some such errors were put right in the same way as some Assurance Offices put right errors in age of an assured life. That is, the Government either treated the contract as for the amount the consideration for it would purchase at the correct age, or required the purchaser to pay up what might be called the arrear of price, with interest; but in 1874 the Government officials then in charge, taking a very different view of the matter, declared contracts where there had been error to be cancelled, and required an accounting at 4 per cent. simple interest, a course upheld by a Vice-Chancellor and afterwards by the Court of Appeal in an action brought against the Atlas Office. In accordance with this judgment, eight Scotch Insurance Offices and a Scotch Bank had to refund among them £18,332 in connection with annuities purchased on two lives thirty years previously. What, in the opinion of the sufferers, made their case particularly hard was the fact that these lives had been selected

from nominees placed on the Government books by other purchasers, a practice provided for in the Act and encouraged by the Authorities.

I am not prepared to say that, under no circumstances, could the holding of Stock of the Bank of England cause alarm to policy-holders, but I am certain that the holding of the Stocks of other Banks might do so, as in times of panic, such as on the failure of the Western and of the City of Glasgow Banks—times when men's minds were much exercised by the far-reaching effect of liability. I have seen policies surrendered both to a mixed and to a mutual office, for very dread of what might have been had the offices held shares in one of those banks. In the case of the Mutual Office, an assurance that the Directors were prohibited from investing in securities carrying liability, and that the office could have paid all the debts of the City of Glasgow Bank without calling on the members to contribute directly, was of no avail. 'Directors did not always keep within their powers, and crushing failures have still to happen.' The limitation of the liability of banks doubtless lessens the feeling of dread entertained of their Stocks, but it has not completely dispelled it, and in the circumstances—though I think the stocks of the Chartered Banks of Scotland offer a very safe and remunerative security —I would hesitate to recommend an Assurance Company to hold them.

Making advances on Reversions and purchasing Reversions, were forms of investment favoured by some Assurance Offices in 1850, as now, but they are not forms of which I have had much experience, owing possibly to prejudice on my part occasioned in some measure by difficulty experienced in exercising powers of sale, at a time when there was not the ready market there is now, and in some measure by the circumstance that before 1867,[1] when a reversion purchased *in England* fell into possession, the purchaser could be called on to show that he had paid a full price for it. Such calls were frequently made, and it was difficult to satisfy the Court that the price paid on the chance of the reversion not falling in for many years was 'full and adequate' when it fell in in few. This was particularly the case when the reversion was of the nature of a *post obit.*

In Scotland there was not the *same* risk in dealing with reversions, or even with *post obits*, but there was another one connected with *post obits*—a difficulty in preventing the grantor's other creditors from obtaining an equal or a preferential ranking

[1] In 1867 it was enacted that 'No purchase, made *bona fide* and without fraud or unfair dealing, of any reversionary interest in Real or Personal estate (in England) shall hereafter be opened or set aside merely on the ground of undervalue' (31 Vic. cap. 4).

on the reversionary estate. I have seen this attempted by inhibition, but have been recently advised that that does not set up so effectual a barrier as was supposed.

I understand that a brother Manager, of much greater experience in such matters, when making advances on reversions takes what on the face of it appears to be an absolute conveyance to the subjects, and gives a power of redemption within an agreed on time on repayment of the purchase money, with interest. I was much taken with this arrangement, as it appeared to me to remove all difficulty in the event of the borrower—for such in reality the seller is—neglecting to pay interest. But I have had doubts, since a conveyancing Counsel to whom I recommended the form declined to use it, holding that the power to redeem, though restricted, made the Deed a Mortgage, and quoting the legal maxim 'once a mortgage always a mortgage.'

Railway Debentures were one form of security taken by Assurance Offices in 1850, at which time it was necessary to look very narrowly into the powers of the borrowing company,[1] and into how these powers had been exercised, and to judge by a note I find on a published balance sheet of the time, they were not regarded as affording unexceptionable security. However, as time went on they came to be more favourably regarded, and were largely held by Assurance Offices.

Early in the sixties public attention was directed to some flagrant abuses of borrowing powers, and in 1864 an enquiry was held by a Select Committee of the House of Lords which resulted in the passing of two important Acts of Parliament—'The Railway Companies Securities Act, 1866' (29-30 Vic. cap. 108), and 'The Railway Companies Act, 1867' (30-31 Vic. cap. 127).

The first requires every railway company in the United Kingdom, authorised by Act of Parliament to raise any Loan Capital, to furnish to the Registrar of Joint Stock Companies in England, half yearly, particulars of the Loan Capital authorised and of the amount thereof issued, and further, that each Mortgage Deed, Bond, or certificate of Debenture Stock issued, is to bear an endorsation by Directors to the effect that the loan capital represented is within the Company's borrowing powers. The other gives 'all money borrowed or to be borrowed by a Company on Mortgage, or Bond, or Debenture Stock, under the provisions of any Act authorising the borrowing thereof . . . priority against the Company and the property from time to time of the Company

[1] On the occasion of a loan to a railway company in 1849, of which I have knowledge, *nineteen* documents had to be produced to satisfy the lenders that the sum required was within the company's borrowing powers. These included Acts of Parliament, certificates by the Sheriff of a County, and affidavits and certificates by the Secretary of the borrowing company.

over all other claims on account of any debts incurred or engagements entered into by them after the passing of this Act' (Section 23).

Before the passing of the Act of 1867, the holders of obligations such as Lloyd's Bonds could 'sue upon them and recover judgment against the Companies; and success in any conflict for priority of claim between them and the holders of Statutory Debentures would appear . . . to be only a question of more or less diligence.'[1]

A Lloyd's Bond is an acknowledgment of indebtedness to a contractor 'for works executed and materials supplied . . . for the purposes of the undertaking, as certified by the Engineer.'

The origin and nature of these Bonds was thus explained to the Select Committee by Mr. Lloyd: 'A railway company had exhausted its borrowing powers; it had not been able to call up the whole of its share capital; some of its shares had been forfeited; the works had turned out more expensive than it was originally estimated they would be, and the directors were in a difficulty; the contractor refused to go on without money; they had no money to pay him; and the question arose what was to be done? It seemed to be an obvious solution of the difficulty that, as there was no prohibition against railway companies securing their debts, which they had *bona fide* contracted for the purpose of their undertaking, they should give him something in the shape of an acknowledgment, under seal, with which he could go to his bankers, or some financial body, and obtain an advance of money, and by that means be enabled to complete the line. The line being completed, the shares would be taken up, or the company would have to come to Parliament to get powers for an increase of capital, and so, by degrees, this floating debt would be extinguished.' Lloyd's Bonds 'are, in fact, nothing more than Railway Exchequer Bonds. They are the representation of a floating debt, which is to be capitalised some time or other, and must be paid, because it is a burden and charge upon the undertaking, which cannot be got rid of except by payment.'[2]

There can be little doubt that Lloyd's Bonds were of great use in the circumstances they were designed to meet, and in some other circumstances, but they came to be abused, and consequently were destroying confidence in Debentures, hence the recommendation of the Committee and the passing of the Act of 1867, which Act has had the effect of restricting their use to companies earning considerably more than suffices to pay Debentures and other obligations over which they can no longer obtain a preference in ranking, and little was heard of Lloyd's Bonds for some years,

[1, 2] *Report of Select Committee on Railway Companies' Borrowing Powers*, 1864.

until the Great Central Railway recently issued them to contractors to the amount of nearly three millions sterling.

In 1867 railway companies were authorised to issue Debenture Stock in place of Debentures, a change which it was thought would be of mutual advantage to the railway companies and to their creditors, but, as things have turned out, the creditors have clearly had the best of it. The companies made a great mistake when they undertook a *perpetual* obligation. They should have given Bonds for a long term of years, as the American Railways did or, what is now common with borrowing governments and companies, reserved the right to repay after a given time with or without a moderate premium.

I would have you note (1) that Debentures and Debenture Stock do not give quite the same security. The Debenture secures repayment of the sum advanced as well as payment of interest, the Debenture Stock merely carries a right to a perpetual annuity equal to the amount of the interest at which the capital was advanced, and which capital can neither be called up by the stockholder or paid off by the railway company; and (2) that American Railway Bonds and British Railway Debentures, or Debenture Stocks, are very differently secured. Many American Railways have issued bonds for more than the line cost to construct and equip. Not so in the United Kingdom. There is a standing order of the House of Lords that railway Bills shall not contain a larger extent of borrowing powers than one-third of the capital authorised by such Bill, which standing order is rarely departed from—never, I believe, to the extent of allowing borrowing of an amount equal to more than one-half of the capital authorised. Moreover, the whole of the authorised share capital issued must be subscribed, and one-half thereof must be paid up before the relative borrowing powers can be exercised.[1]

Thirty years ago, when I was buying Ground Annuals at twenty-two and a half years' purchase, and Railway Debenture Stock to yield 4½ per cent., I told your Society that in my opinion an increase of capital, and of security to the possessors of it, would be accompanied by a gradual fall in the return to be obtained on investments. My forecast has proved to be in some measure correct; I say in some measure, as I certainly never anticipated so rapid or so great a fall as we have experienced, the return from such investments as I have named being now but two-thirds of

[1] Railways constructed by authority of the Board of Trade under 'The Railways Construction Facilities Act, 1864' (27 and 28 Vic. cap. 121) are not allowed to borrow 'a larger sum in the whole than one-third of the share capital authorised by the certificate' granted them by the Board of Trade, and cannot exercise this power 'until the whole of the share capital is subscribed for or taken, and until one-half thereof is actually paid.'

what it was. There has of late been an improvement; still I have very little hope of the tendency to fall being permanently arrested, but at the same time very little fear that any further fall will be rapid.

I attribute the fact that capital has of late commanded a better return partly to an unusual demand for it for purposes of commerce, but principally to the War in South Africa, and to the unsatisfactory position of matters in China. It is too much to expect that the present demands of commerce will last for ever, and War has not the permanent effect on Wealth (or Capital) with which some persons credit it. For one thing Wars are now shorter than they used to be, and though much Capital is directly destroyed, and National Savings are arrested, the whole pecuniary loss appears small when compared with the annual increase of wealth in most countries, and it sometimes happens, as I doubt not will be the case in South Africa, that the pecuniary loss is in time more than met by the increased prosperity resulting from changes brought about by War.

The immediate effect of War is to, more or less, drain the countries engaged in it of currency, usually gold, for the war chest, which in connection with a banking system such as ours leads to an increase of the bank rate for discounts, and that, with a general feeling of uncertainty, cripples credit. Capitalists hesitate to employ their capital, speculators hasten to realise what they hold and to sell for a fall—prices of marketable securities are beaten down and their fall exercises a depressing influence on other values. The *apparent* loss of wealth in the community is something appalling, though fortunately the actual loss only falls on those who have to part with their holdings before confidence is restored.

Some new and remunerative employment for Capital may arise and help to keep up the return upon the whole of the world's accumulations, but it is difficult, it is scarcely possible, to conceive of any general requirement that will at all compare with Railway Construction. Scarcely possible, I say, when I consider the vast amount of capital that Railway Construction has in the last fifty years taken up, and still takes up, though now in an ever-decreasing proportion to the supply—a supply which it probably more than any other use of capital helped to create.

And now, gentlemen, before I close I have something to say to you about your Society, and some advice to offer which I am sure you will take in good part, though it may appear strange coming from one so recently honoured with the position of President.

Your Society was founded full forty years ago, at the instance of Members of the Faculty of Actuaries, for the purpose of drawing together such of the young men employed in their Offices as desired to acquire a knowledge of the theory, as well as of the practice of their business, encouraging them to assist in raising the status of the profession to which they were devoting their time and talents, and to qualify for advancement in it.

The Faculty of Actuaries was then too small a body to undertake frequent meetings with its students, and, moreover, many of those students regarded the original Fellows of the Faculty, or such of them as were principals of Assurance Offices, with such deference, that it was seen few would care to give expression to their views on any subject, by reading a paper, or taking part in a discussion, in a mixed assembly; otherwise it is probable there would have been but one actuarial body, as in England.

The Society has well served the purpose of its founders. Thanks in great measure to it, the Faculty is now a by no means inconsiderable body, and as many of the present day Fellows have for years been members of the Society, taking an active interest in its proceedings, their juniors are accustomed to meet them on equal terms.

I therefore see no reason why there should any longer be two bodies, and am glad to know that there is a movement on foot among you to merge the Society in the Faculty, and that your Committee of Management have gone so far as to instruct a sub-committee, appointed to confer with a sub-committee of the Faculty, that they 'will recommend the dissolution of this Society, provided the Faculty make arrangements to continue the purposes of the Society and its stated meetings, and, as far as reasonably practicable, the rights of its members.' Gentlemen, such a step was foreshadowed years ago, but it appears to me that at no time have we had so fair a prospect as now of its being taken up with success, as we have in the present President of the Faculty, and in my immediate predecessor in this Chair—who was the first to read a paper before the Society, and has read many most valuable papers since—two of the most able supporters and best friends of the Society, gentlemen who have the interests of both Faculty and Society at heart. I need hardly add that if you approve of the action of your Committee of Management, I shall esteem it a privilege to assist in a movement which, I believe, will strengthen the Faculty, improve the status of the Scottish Actuary, and serve to make the seniors of our profession better acquainted with their juniors.

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On the construction of a Table of Mortality

BEING

THE INAUGURAL ADDRESS FOR SESSION 1899-1900

BY

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HONORARY PRESIDENT OF THE SOCIETY.

On the construction of a Table of Mortality

GENTLEMEN,—Allow me to thank you very cordially for electing me to preside over your meetings during the ensuing Session. It is an honour very greatly appreciated by every one who has been selected to fill this chair. Indeed I feel doubly honoured, seeing that I am the first to address you in the new Hall of the Faculty of Actuaries under the gaze of the stony eyes of our own immortal Napier. Your election reminds me that I had the honour of presiding over your earliest meetings and that I also had the pleasure of reading the earliest papers that were presented for your consideration. These three papers I am proud to believe have been diligently perused by nearly every student of Actuarial Science, forming as they do the wicket opening into wider fields, the earliest lessons of the course. They have, as I have been told, been the guiding rays of light which induced some of our most eminent Actuarial stars, presently shining in our firmament, to follow in the pursuit of higher knowledge, and to join the profession. These simple papers have been printed three times, and are again out of print. Gentlemen, I do wish I were able to repeat that enthusiasm. It seems to me now to be a much more simple matter to find language to describe something which one is striving to understand for oneself, and labouring to make clear to one's own comprehension, than to write an essay upon something which appears so plain and so palpable that the wonder is how any one could fail to interpret the language of the symbols. These efforts were made long long ago, long before the mind was clouded by care or ruffled by the multitude of many disquietudes, and at a time when the energies were fresh and the heart was young; but as Tupper says:—

'Light as flakes of falling snow,
  Drop the silent-footed hours,
And the days—they come and go,
And the years—we scarcely know
  How their frosts and fruits and flowers—

Transient crops of weal and woe—
Change and pass and perish so.
While we muse upon to-day,
Lo! the dream has died away,
And there lives what was to-morrow,
With its present joy or sorrow.
So on—so on—till years have sped
By tens and twenties over head,
And those flakes that fell unfelt
Have changed to snows that never melt!'

Gentlemen, it has hitherto been the custom for the person whom you honour to fill this chair to open the Session by an address—touching lightly upon some of those points of our business that recent events have rendered of pressing, though it may be of only passing, importance. Such a theme is not beyond my ambition, but it is entirely out of the reach of my leisure and of my opportunities. My pen has been so much occupied plodding to the circumstances, and to the affairs of practical business, that I could not find the needful time to revel amongst these flowery fields. I have chosen another task. I have thought that I would be carrying out the objects and the aims of this Society by dwelling upon some subject on the level ground of our business, and treating it rather in an elementary and in an educative manner, than attempting to soar to higher and more hazardous themes. The results of such lofty ambitions might be that we may become

'Blind unto the beautiful in common things that strew the common way.'

One special subject, however, has been engaging my attention for some time, and I have preferred, if you will be pleased to listen till the conclusion of my reflections, to dwell very much in detail upon the processes and upon the principles which to my mind ought to be kept in view in the congregation and collection of the necessary materials—in the combination of these materials, and in the concluding development and completion of these materials into a Table of Mortality. I feel very seriously the importance of my task, indeed, I have almost undertaken to do too much. A Table of Mortality is the instrument by which are performed all calculations depending upon the continuance of life—by its aid we lift the dark and obscure curtain of the future and measure longevity—parcelling out with some confidence the total number of years a multitude of persons are likely to live—by its aid we determine the value of engagements to pay annuities during life, or of capital sums payable at the termination of life, and of many other variations and combinations of life, and of death which the ingenuity of man has devised. In these circumstances you will be able to estimate the importance of the problem, and inasmuch

as this instrument, if it be false, may lead immensely astray, the construction of a Table of Mortality should receive the supreme consideration of our undivided efforts.

In the execution of these aspirations I propose to divide my subject into several well-defined sections, and, as has been suggested to me, to devote more than one evening to their consideration. Many points of considerable importance have to be referred to—and as some of my modes of treating these points are probably new to most of you, I hope you will deem them worthy of your attention.

If we consult the volumes wherein the experience of the seventeen Offices were published in 1839, or wherein the more matured results of the twenty Offices of the $H^{M.}$ Table in 1868 were detailed, we feel that many links of much desired information are amissing. Upon these missing links I propose to dwell with correspondingly increased attention, or rather I shall so bestow my remarks upon the several sections and sub-sections of the compilation of a Table of Mortality as to give increased prominence to those details that have, with such apparent facility, been passed over in the two published tables based upon the experience of assured lives.

The first section of my subject is the processes to be employed in the collection of the facts preparatory to the ascertainment of the rate of mortality. The rate of mortality, at any age, is the ratio of the number of that age dying in one year, to the total number who enter upon that year of age and remain exposed to mortality during that year. Unquestionably the best method of collecting the material is to write the facts of each life, or of each policy on a card—not on loose cards, which have opportunities of becoming scattered—some here, some there—some in this desk, and some in that drawer—some complete and others incomplete —but written on sheets of thick paper, each sheet containing say 16 cards, and bound in volumes, say, of 160 leaves, so that each volume would contain the facts of 2560 policies. The printing is so arranged that the part of one sheet occupied by the print, 'registers' identically with the same part of all the other sheets. 'Registering,' as understood by printers, is the placing of each sheet of paper in exactly the same spot of the printing press, so that each impression registers or coincides with all the others. Thus a sheet is said to be correctly registered when the number of each page falls exactly on the number of the page on the other side of the sheet. A very slight attention attains this result. Previous to being bound each sheet has been passed through a numbering machine which mechanically prints numbers in arithmetical order on the top line of the card corresponding to the numbers of the Policies in the office records.

ink. When, however, the assured was alive at the close of the observations, the date of exit was left blank and the age at exit was written in pencil, in order that the same card may be again used on a subsequent examination of the experience. These ages at exit are readily obtained from a table[1] showing the ages for all dates of birth.

The other two modes of exit are either by lapse or surrender, or by Death. In the former case the letter W (withdrawal) was inserted in the line of mode of exit. In the latter case the letter D was inserted. The ages were thus either—

$\frac{32\cdot5}{48\cdot9}$ for the existing, $\frac{32\cdot5}{48\cdot9}$ W for the withdrawer, or $\frac{32\cdot5}{48\cdot9}$ D for the died.

If all the lives, whose mortality experience was being examined, possessed the same character of risk, the entries would all be made in one colour of ink, say black ink—but if there were other risks of various characters—Temporary Assurances, Endowment Assurances, etc.—risks charged at a higher premium for some supposed defect from the standard of healthy lives, or for residence in a climate not covered by the ordinary premiums charged for healthy lives in this country, the healthy home risks only would be written in black ink and all other risks written in red ink. The volume of 2560 Policies being now complete, the facts compared, the durations and ages inserted, it is sent to the bookbinder for the purpose of being guillotined into separate cards. This machine is very powerful and performs the operation in a few minutes. The effect of 'registering' the printing is now seen in the exactness of the separate cards. The knife of the guillotine has passed exactly through the division of the cards, and they possess a sharply cut edge which greatly assists correctness in the reckoning of their

[1] Extract from Table of Ages at *Exit* of the Living.

Year of Birth.	Month of Birth.											
	1	2	3	4	5	6	7	8	9	10	11	12
1855	43·11	43·10	43·9	43·8	43·7	43·6	43·5	43·4	43·3	43·2	43·1	43·0
1856	42·11	42·10	42·9	42·8	...	...	...	...	...	...	...	42·0
1857	41·11	41·10	41·9	41·8*	...	...	...	...	...	...	...	41·0
1858	40·11	40·10	40·9	...	...	...	...	...	...	...	...	40
1859	39·11	39·10	39·9	...	...	...	...	...	...	...	...	39
1860	38·11	38·10	38·9	...	...	...	...	...	...	...	...	38

* Thus a person born in April 1857 would be entered (in pencil) as of age 41·8 at December 1898.

numbers, and altogether the whole of the work up to this point is all that could be desired, and is much superior to that resulting from the adoption of loose cards. We now possess 2560 cards from each volume, complete and ready for manipulating their facts—changing them from a general chaos into something of law and order for the purpose of ascertaining the rate of mortality at each of the ages of life. These cards are then to be separated into those of healthy home risks, and into other classes. The next step is to classify the names in order to gather the facts of Policies that referred to the same life, and to incorporate these cards as the facts of one entry if the risks have been continuous. If continuous, the cards of the continuous risks were put into envelopes specially constructed, of which I show specimens, and the facts of the continuous risk were written on the envelope thus—

$$\frac{32\cdot5}{48\cdot9}\ \mathbf{L} \qquad \frac{32\cdot5}{48\cdot9}\ \mathbf{W} \quad \text{or} \quad \frac{32\cdot5}{48\cdot9}\ \mathbf{D}$$

We now possess the cards of the experience ready for tabulation and it will now be our efforts to arrange them so as to ascertain the numbers who are of the same age. This tabulation falls naturally to be divided into three sections—

One section for the Living,
Another „ „ Withdrawls,
And a third „ „ Died,

and each of these into two sub-sections—their ages at entry and their ages at exit.

You will have observed that the ages recorded on the cards were expressed in the form of a fraction, thus—

Age at entry $= 37\cdot5$
Age at exit $= 43\cdot8$
Duration $= 6\cdot\frac{3}{12}$ years.

That is to say, there were seven months remaining of the 37-38th year of life exposed to mortality, thereafter the life was at risk for five complete years, from 38 to 43, and there were eight months of the year of life 43-44 exposed, in all six years and three months as in the last column of the accompanying chart. When these facts are tabulated according to my process of tabulation they appear as follows, and first let the tabulation have reference to a single life, thus—

Year of life.	Entrants.			Exitants.			Difference being years of life exposed to mortality.
	Number.	Net Value.	Progressive summation.	Number.	Net Value.	Progressive summation.	
37-38	$1\cdot^{-5}$	·7	·7	...	...	...	·7
38-39	·5	·5	1·	...	...	...	1·
39-40	...	...	1·	...	...	...	1·
40-41	...	...	1·	...	...	...	1·
41-42	...	...	1·	...	...	...	1·
42-43	...	...	1·	...	...	...	1·
43-44	...	...	1·	$1\cdot^{-8}$	·4	·4	·8
44-45	...	...	1·	·8	·8	1·	...
	...	...	1·	...	...	1·	...
Sums	1·	1·	8·7	1·	1·	2·4	6·3

It will be seen that the total number of years of life exposed to mortality ($6\cdot\frac{3}{12}$) is equal to the difference between the separate progressive summations of the Entrants and of the Exitants ($8\cdot7-2\cdot4=6\cdot3$).

If there were six cards, thus:

	37·5	38·6	39·7	40·8	41·9	42·10	
	43·8	43·8	43·8	43·8	43·8	43· 8	
Durations=	6·3	5·2	4·1	3·	1·11	·10	=21·3

the first step in the tabulation would have reference to the Entrants and to their ages at entry, thus:

Age.	Number.
37-38	$1\cdot^{-5}$
38-39	$1\cdot^{-6}$
39-40	$1\cdot^{-7}$
40-41	$1\cdot^{-8}$
41-42	$1\cdot^{-9}$
42-43	$1\cdot^{-10}$
43-44	...

These are all the entries obtained from the cards, but bearing in mind that the first life entered upon the risk at age $37\cdot\frac{5}{12}$, there accordingly remained only seven months of that year of life (37-38) exposed to risk, and inasmuch as the risk was continued into subsequent years there were five months of the following year of life (38-39) entered upon, together making up a whole year of

life at that age, and so on for other years. Similarly with the life entering at age $38\cdot\frac{6}{12}$, there were six months exposed in the year of life 38-39 and other six months in the year of life 39-40, which together make up a whole year of life, and so on. The tabulation of the numbers entering thus becomes:

Age.	Number.	Net Number.	Progressive Summation.
37-38	$1\cdot^{-5}$	·7	·7
38-39	$1^{\cdot 5-6}$	·11	1·6
39-40	$1^{\cdot 6-7}$	·11	2·5
40-41	$1^{\cdot 7-8}$	·11	3·4
41-42	$1^{\cdot 8-9}$	·11	4·3
42-43	$1^{\cdot 9-10}$	·11	5·2
43-44	^{10}	·10	6·
Sums—	6·	6·	23·3

It does not matter how long the progressive sum for the entrants is continued, provided a like progressive summation for the exitants is similarly continued. Accordingly up to the close of the observations these six lives passed through $23\cdot\frac{3}{12}$ years. When now we perform the same calculation for the six who all leave the observations at age $43\frac{8}{12}$, thus:

Age.	Number.	Net Number.	Progressive Summation.
37-38			
38-39			
39-40			
40-41			
41-42			
42-43			
43-44	$6\cdot^{-48}$	2·—	2·
44-45	$+^{48}$	4·—	6·
	6·	6·	6·

The net number of years of life will be the difference between the two progressive summations:

Age.	Progressive Sums.		Difference.	
	For the Entrants.	For the Exitants.	Years of Life exposed to Mortality.	
37-38	·7		·7	
38-39	1·6		1·6	
39-40	2·5		2·5	
40-41	3·4		3·4	
41-42	4·3		4·3	
42-43	5·2		5·2	
43-44	6·	2·—	4·	
44-45	6·	6·—	...	
	6·	6·—	...	
Sums—	35·3	– 14·	=21·3	=Net number exposed, as previously shown.

If there be a promiscuous lot of cards of various ages at entry, it is sometimes convenient to arrange the facts in the following manner and to sum up the months while the cards at each age are passed through the fingers:

Age.	Number of Lives.	Sum of Months in excess of Integral Age.
14	2	— 21
15	4	— 10
16	11	— 74
17	13	— 72
18	21	— 135
19	45	— 263
20	69	— 423
21	132	— 796
22	162	—1035
23	189	—1176
24	233	—1360
etc.	etc.	

and completing the calculation of the net number of years and months entering upon and passing through each year of life, thus:

Year of Life.	Number of Lives.	Sum of Months in excess of Integral Age.	Net Number entering upon each Year of Life.
14-15	2	— 21	= ·3
15-16	4	21 — 10	= 4·11
16-17	11	10 — 74	= 5·8
17-18	13	74 — 72	= 13·2
18-19	21	72 — 135	= 15·9
19-20	45	135 — 263	= 34·4
20-21	69	263 — 423	= 55·8
21-22	132	423 — 796	= 100·11
22-23	162	796 — 1035	= 142·1
23-24	189	1035 — 1176	= 177·3
24-25	233	1176 — 1360	= 217·8
etc.	etc.		

It will generally be found convenient to arrange the tabulation in a more general form, considerably diminishing the labour and reducing the risk of error. The first part is extracted from the cards.

TABULATION OF THE CARDS AS FOR THE AGES ON ENTERING UPON THE RISK.

Preliminary Tabulation of the Number entering the Risk at each Month of Age.

Age.	0	1	2	3	4	5	6	7	8	9	10	11	Total.
14	...	...	...	...	...	...	...	...	...	...	1	1	2
15	2	...	1	...	...	...	...	...	1	...	...	...	4
16	3	...	...	...	1	...	...	1	...	1	1	4	11
17	2	1	...	1	...	2	2	1	...	2	1	1	13
18	1	1	...	3	...	4	2	1	3	1	2	3	21
19	9	2	1	2	2	1	6	4	2	5	6	5	45
20	12	3	...	5	2	5	6	5	6	9	4	12	69
21	24	10	6	6	4	6	7	11	8	4	15	31	132
22	23	4	3	16	10	9	9	10	17	12	15	34	162
23	27	8	6	14	14	10	14	14	10	11	24	37	189
24	50	10	8	8	6	19	19	16	18	15	20	44	233
etc.				etc.					etc.				etc.

The subsequent calculation of the number of months when these lives entered upon the risk at ages, in excess of the integral ages on the margin of the above, follows as a matter of course, and is of the simplest description. If the above be tabulated on alternate lines the total number of months may be entered upon the intermediate line and written in red ink, as shown here in darker type. Thus :—

COMPLETE CALCULATION OF THE NUMBER OF MONTHS THE LIVES ENTERED IN EXCESS OF THEIR INTEGRAL AGE.

Age.	0	1	2	3	4	5	6	7	8	9	10	11	Total number entering.	Total months in excess of integral age.
14	...	...	...	...	...	...	...	...	...	...	1	1	2	
											10	11		21
15	2	...	1	...	...	...	...	...	1	...	...	...	4	
			2						8					10
16	3	...	...	...	1	...	...	1	...	1	1	4	11	
					4			7		9	10	44		74
17	2	1	...	1	...	2	2	1	...	2	1	1	13	
		1		3		10	12	7		18	10	11		72
18	1	1	...	3	...	4	2	1	3	1	2	3	21	
		1		9		20	12	7	24	9	20	33		135
19	9	2	1	2	2	1	6	4	2	5	6	5	45	
		2	2	6	8	5	36	28	16	45	60	55		263
20	12	3	...	5	2	5	6	5	6	9	4	12	69	
		3		15	8	25	36	35	48	81	40	132		423
21	24	10	6	6	4	6	7	11	8	4	15	31	132	
		10	12	18	16	30	42	77	64	36	150	341		796
22	23	4	3	16	10	9	9	10	17	12	15	34	162	
		4	6	48	40	45	54	70	136	108	150	374		1035
23	27	8	6	14	14	10	14	14	10	11	24	37	189	
		8	12	42	56	50	84	98	80	99	240	407		1176
24	50	10	8	6	8	19	19	16	18	15	20	44	233	
		10	16	18	32	95	114	112	144	135	200	484		1360
Sums	153	39	25	53	41	56	65	63	65	60	89	172	=881	
	..	39	50	159	164	280	390	441	520	540	890	1892	=	5365

By the aid of a table[1] the equivalent years and months for any number of months are readily obtained.

Having now obtained the exact number entering the risk of mortality in each year of age, the total number passing through each higher year of age is found by a progressive summation down the column, and having pursued the same process for the number exiting from the risk, the difference between the sums at each age in these progressive summations will give the net numbers exposed to mortality in each year of life, as in the following example of the number exposed to mortality from among those who are alive at the close of the observations :—

	Entrants.			Exitants.			
Age at Entry.	Number of Entrants.	Entrants re-allocated to exact ages at entry.	Progressive sum of these Entrants.	Number of Exitants.	Exitants re-allocated to exact ages at exit.	Progressive sum of these Exitants.	Years of life exposed to Mortality.
14	2	·3	*·3*	...	...	...	·3
15	4	4·11	*5·2*	...	...	...	5·2
16	11	5·8	*10·10*	...	...	...	10·10
17	13	13·2	*24·*	...	...	...	24·
18	21	15·9	*39·9*	...	...	...	39·9
19	45	34·4	*74·1*	...	...	...	74·1
20	69	55·8	*129·9*	...	...	...	129·9
21	132	100·11	*230·8*	...	...	...	230·8
22	162	142·1	*372·9*	...	...	...	372·9
23	189	177·3	*550·*	...	...	...	550·
24	233	217·8	*767·8*	...	...	...	767·8
25	266	257·11	*1025·7*	...	...	...	1025·7
26	276	262·7	*1288·2*	...	...	...	1288·2
27	286	291·9	*1579·11*	...	...	...	1579·11

[1] Table of the Equivalent Years and Months for any Number of Months.

Months	100	200	300	400	500	etc.
1	8· 5	16· 9	25·1	33·5	41·9	
2	8· 6	16·10	25·2	etc.		
3	8· 7	16·11	etc.			
4	8· 8	17·				
5	8· 9	17· 1				
6	8·10	17· 2*				
7	8·11	17· 3				
8	9·	17· 4				
9	9· 1	17· 5				
10	9· 2	17· 6				
etc.	etc.	etc.				
100—	16· 8	25·	33·4	41·8		

* Thus 206 months are equivalent to 17 years and two months.

Entrants.				Exitants.			
Age at Entry.	Number of Entrants.	Entrants re-allocated to exact ages at entry.	Progressive sum of these Entrants.	Number of Exitants.	Exitants re-allocated to exact ages at exit.	Progressive sum of these Exitants.	Years of life exposed to Mortality.
28	304	299·6	*1879·5*	...	..	...	1879·5
29	312	313·2	*2192·7*	...	...	...	2192·7
30	306	299·6	*2492·1*	...	...	...	2492·1
31	264	292·7	*2784·8*	...	...	...	2784·8
32	216	234·2	*3018·10*	...	...	...	3018·10
33	188	202·	*3220·10*	...	...	...	3220·10
34	201	187·4	*3408·2*	...	...	...	3408·2
35	175	195·9	*3603·11*	...	...	...	3603·11
36	125	151·6	*3755·5*	...	...	..	3755·5
37	132	113·10	*3869·3*	...	...	...	3869·3
38	119	131·9	*4001·*	...	...	...	4001·
39	90	104·2	*4105·2*	...	...	...	4105·2
40	87	90·9	*4195·11*	...	...	...	4195·11
41	68	73·1	*4269·*	...	...	...	4269·
42	46	54·11	*4323·11*	3	1·3	*1·3*	4322·8
43	42	43·6	*4367·5*	4	4·5	*5·8*	4361·9
44	42	45·	*4412·5*	3	2·7	*8·3*	4404·2
45	20	24·9	*4437·2*	6	4·6	*12·9*	4424·5
46	21	21·3	*4458·5*	12	9·8	*22·5*	4436·
47	19	21·3	*4479·8*	43	24·3	*46·8*	4433·
48	16	16·11	*4496·7*	42	48·5	*95·1*	4401·6
49	12	14·1	*4510·8*	56	45·9	*140·10*	4369·10
50	13	11·10	*4522·6*	73	65·4	*206·2*	4316·4
51	7	8·	*4530·6*	99	83·1	*289·3*	4241·3
52	5	6·3	*4536·9*	114	114·3	*403·6*	4133·3
53	6	5·9	*4542·6*	136	119·	*522·6*	4020·
54	5	5·4	*4547·10*	139	141·3	*663·9*	3884·1
55	2	3·	*4550·10*	163	154·	*817·9*	3733·1
56	2	2·10	*4553·8*	190	178·4	*996·1*	3557·7
57	1	1·3	*4554·11*	195	190·10	*1186·11*	3368·
58	...	·1	*4555·*	185	190·2	*1377·1*	3177·11
59	...	...	*4555·*	179	174·2	*1551·3*	3003·9
60	...	...	*4555·*	173	175·3	*1726·6*	2828·6
61	...	...	...	186	183·10	*1910·4*	2644·8
62	...	...	...	164	176·6	*2086·10*	2468·2
63	...	...	...	186	178·11	*2265·9*	2289·3
64	...	...	...	167	169·7	*2435·4*	2119·8
65	...	...	*4555·*	193	191·9	*2627·1*	1927·11
66	...	...	...	173	175·11	*2803·*	1752·
67	...	...	...	186	177·9	*2980·9*	1574·3
68	...	...	...	153	164·7	*3145·4*	1409·8
69	...	...	...	157	161·7	*3306·11*	1248·1
70	...	...	*4555·*	150	155·5	*3462·4*	1092·8
71	...	...	...	117	134·7	*3596·11*	958·1
72	...	...	...	121	111·3	*3708·2*	846·10
73	...	...	...	107	121·	*3829·2*	725·10
74	...	...	...	97	100·7	*3929·9*	625·3
75	...	...	*4555·*	98	97·2	*4026·11*	528·1
76	...	...	...	87	82·11	*4109·10*	445·2
77	...	...	...	78	89·3	*4199·1*	355·11
78	...	...	...	56	61·	*4260·1*	294·11

Entrants.				Exitants.			
Age at Entry.	Number of Entrants.	Entrants re-allocated to exact ages at entry.	Progressive sum of these Entrants.	Number of Exitants.	Exitants re-allocated to exact ages at exit.	Progressive sum of these Exitants.	Years of life exposed to Mortality.
79	...	...	...	58	60·11	*4321·*	234·
80	...	...	*4555·*	46	54·1	*4375·1*	179·11
81	...	...	...	37	38·5	*4413·6*	141·6
82	...	...	...	25	33·	*4446·6*	108·6
83	...	...	...	22	23·7	*4470·1*	84·11
84	...	...	...	21	18·8	*4488·9*	66·3
85	...	...	*4555·*	14	19·1	*4507·10*	47·2
86	...	...	...	15	14·6	*4522·4*	32·8
87	...	...	...	7	11·8	*4534·*	21·
88	...	...	...	9	6·3	*4540·3*	14·9
89	...	...	...	1	5·4	*4545·7*	9·5
90	...	...	*4555·*	4	3·	*4548·7*	6·5
91	...	...	...	2	2·6	*4551·1*	3·11
92	...	...	...	2	1·6	*4552·7*	2·5
93	...	...	...	...	1·5	*4554·*	1·
94	...	...	...	...	...	*4554·*	1·
95	...	...	*4555·*	...	...	*4554·*	1·
96	...	...	*4555·*	1	·2	*4554·2*	·10
97	...	...	*4555·*	...	·10	*4555·*	...

Exactly the same process would be performed with the cards of those who have withdrawn from the risk during the course of the observations which need not be repeated.

The cards of the Died would be treated differently in the year of death. Since we are determining the rate of mortality per annum, the Died would be assumed to be on the risk up to the end of the year of age in which they died. That is, they would be taken off the risk then, being careful, however, to remember that they would be on the risk during that year. An extract from the calculations for the same lives will illustrate the point.

Age.	Number of Entrants.	Entrants reallocated to exact ages at entry.	Progressive sum of these Entrants.	Number dying.	Progressive sum of number of deaths.	Years of life exposed to Mortality.
14	4	·6	*·6*	...	...	·6
15	4	4·4	*4·10*	...	...	4·10
16	5	4·2	*9·*	...	...	9·
17	6	6·7	*15·7*	...	...	15·7
18	10	8·4	*23·11*	1·	*1*	22·11
19	26	13·11	*37·10*	...	*1*	36·10
20	36	34·9	*72·7*	1·	*2*	70·7
21	73	56·	*128·7*	...	*2*	126·7
22			*208·6*	4·	*6*	202·6
23			*321·5*	6·	*12*	309·5
24			*484·10*	3·	*15*	469·10
25			*688·7*	14·	*29*	659·7
						etc.

And now finally I produce the total number exposed to Mort
from the three Sections—the Living—the Withdrawn—and
Died.

YEARS OF LIFE EXPOSED TO MORTALITY.

Age.	From the Living.	From the Withdrawn	From the Died.	Total.	Des
9	...	·8	...	·8	..
10	...	1·	...	1·	..
11	. .	1·	...	1·	..
12	...	1·	...	1·	..
13	...	2·4	...	2·4	..
14	·3	3·5	·6	4·2	..
15	5·2	4·4	4·10	14·4	..
16	10·10	10 9	9·	30·7	..
17	24·	17·1	15·7	56·8	.
18	39·9	31·10	22·11	94·6	..
19	74·1	60·3	36·10	171·2	.
20	129·9	96·8	70·7	297·	..
21	230·8	155·8	126·7	512·11	.
22	372·9	238·1	202·6	813·4	(
23	550·	335·1	309·5	1194·6	.
24	767·8	436·9	469·10	1674·3	1
25	1025·7	560·11	659·7	2246·1	1
26	1288·2	660·8	882·8	2831·6	1
27	1579·11	771·1	1124·9	3475·9	2
28	1879·5	875·3	1388·7	4143·3	2
29	2192·7	964·	1693·5	4850·	2
30	2492·1	1044·10	2019·1	5556·	4
31	2784·8	1129·10	2286·7	6201·1	4
32	3018·10	1176·5	2583·7	6778·10	4
33	3220·10	1211·5	2860·9	7293·	5
34	3408·2	1240·6	3129·9	7778·5	5
35	3603·11	1284·11	3403·1	8291·11	7
36	3755·5	1282·	3645·5	8682·10	6
37	3869·3	1278·5	3893·9	9041·5	8
38	4001·	1267·7	4079·	9347·7	7
39	4105·2	1244·5	4276·6	9626·1	7
40	4195·11	1215·7	4489·4	9900·10	8
41	4269·	1170·8	4623·3	10062·11	9
42	4322·8	1146·11	4753·8	10223·3	9
43	4361·9	1097·4	4853·6	10312·7	9
44	4404·2	1040·7	4935·6	10380·3	11
45	4424·5	969·8	4997·10	10391·11	11

YEARS OF LIFE EXPOSED TO MORTALITY—*continued.*

Age.	From the Living.	From the Withdrawn.	From the Died.	Total.	Deaths.
46	4436·	918·6	5030·1	10384·7	103
47	4433·	861·11	5040·5	10335·4	124
48	4401·6	800·1	5031·1	10232·8	121
49	4369·10	740·8	5001·2	10111·8	111
50	4316·4	688·11	4974·9	9980·	154
51	4241·3	624·3	4889·5	9754·11	162
52	4133·3	566·7	4787·1	9486·11	158
53	4020·	512·2	4678·2	9210·4	147
54	3884·1	455·10	4587·3	8927·2	158
55	3733·1	405·11	4479·8	8618·8	170
56	3557·7	359·1	4339·9	8256·5	166
57	3368·	326·8	4212·7	7907·3	152
58	3177·11	289·10	4097·7	7565·4	165
59	3003·9	261·5	3960·1	7225·3	177
60	2828·6	232·9	3800·7	6861·10	203
61	2644·8	206·7	3612·2	6463·5	191
62	2468·2	190·1	3438·6	6096·9	189
63	2289·3	167·1	3257·3	5713·7	204
64	2119·8	141·10	3061·	5322·6	197
65	1927·11	124·10	2874·1	4926·10	197
66	1752·	106·6	2684·	4542·6	183
67	1574·3	87·10	2505·8	4167·9	177
68	1409·8	75·	2331·8	3816·4	196
69	1248·1	62·4	2140·1	3450·6	172
70	1092·8	53·	1972·6	3118·2	192
71	958·1	44·3	1781·2	2783·6	182
72	846·10	36·1	1601·11	2484·10	190
73	725·10	33·5	1314·9	2074·	167
74	625·3	29·2	1250·	1904·5	168
75	528·1	23·8	1082·	1633·9	169
76	445·2	21·7	913.	1379·9	136
77	355·11	17·5	777·	1150·4	132
78	294·11	13·1	645·	953·	102
79	234·	10·2	543·8	787·10	110
80	179·11	9·7	434·	623·6	92
81	141·6	9·	342·	492·6	78
82	108·6	8·	264·	380·6	46
83	84·11	6·9	218·	309·8	53
84	66·3	5·	165·	236·3	36
85	47·2	3·1	129·	179·3	37
86	32·8	2·8	92·	127·4	27
87	21·	1·3	65·	87·3	18

YEARS OF LIFE EXPOSED TO MORTALITY—*continued.*

Age.	From the Living.	From the Withdrawn.	From the Died.	Total.	Deaths.
88	14·9	·11	47·	62·8	17
89	9·5	...	30·	39·5	10
90	6·5	...	20	26·5	8
91	3·11	...	12·	15·11	4
92	2·5	...	8·	10·5	3
93	1·	...	5·	6·	2
94	1·	...	3·	4·	2
95	1·	...	1·	2·	...
96	·10	...	1·	1·10	...
97	...	...	1·	1·	1
	152,575·	33,563·8	176,380·3	362,518·11	7322

The foregoing method of ascertaining the years of life exposed to Mortality is strictly correct, and, when properly gone about, is not attended with any greater trouble than the methods where integral years only are adopted. One of these methods is to assume that the life entered at his nearest birthday and thereafter to follow the exposure through policy years. This method assumes policy years to be all integral years, which they certainly are not. Many policy years are in half-years or in quarter-years. Many of those that are yearly are withdrawn from risk at intermediate periods of the year. It occurred to me to test whether this method tends to gravitate towards one side. If all the lives entered at intervals under six months of their ages at entry and they were assumed to have entered at their nearest integral age, the integral ages at entry would all be *under*stated. If all the lives entered at intervals over the six months of their ages at entry, and were taken to have entered at their next nearest birthday, the ages would all be *over*stated. And if those who entered under $x+\frac{6}{12}$ were taken as of age x, and those who entered over $x+\frac{6}{12}$ were taken as of $x+1$, and if all who entered at exactly $x+\frac{6}{12}$ were taken, one half at age x, and the other half at age $x+1$, probably a sufficient adjustment may have been made. From the jotting made with the materials in my possession, I formed the opinion that the above method of integral years slightly overstates the rate of mortality. This method has also been officially pronounced unsuitable for the experience of Endowment Assurances, which alone is a sufficient condemnation of the method. When applied to Sickness experience the method is exceedingly interesting.

Before referring to the methods followed in producing the Seventeen Offices and the H^M tables, allow me to show you a method

of tabulation, when integral ages are employed, of exhibiting the years of life exposed to mortality of the three classes separately, the Living, the Discontinued, and the Died, which was followed in the development of the experience of the Scotch Offices in 1863.

I simply ran up "broad sheet" tables of the entrants and the exits of each class. Thus:

I. THE EXISTING.

Age at Entry.	Ages a Exit											Total No. of Entrants of the Living.
	1	2	3	4	5	6	7	8	9	10	11 etc.	
1	5	3	1	3	1	3	2	1	...	2	etc.	28
2		...	1	1	1	1	...	2	3	1		16
3	5		...	1	...	2	...	1	...	...		9
4		3		2	3	...	...	1	3	...		12
5			2		1	1	1	1	1	...		16
6				7		3	1	...	1	...		17
7					6		3	2	2	1		24
8						10		1	3	1		35
9							7		1	3	etc.	37
10								9		4		46
									14			
										12	etc.	

II. THE DISCONTINUED.

Age at Entry.	Ages at Exit.											Total No. of Entrants of the Discontinued.
	1	2	3	4	5	6	7	8	9	10	etc.	
1	...	2	1	2	...	...	2	2	2	...		14
2		...	1	...	...	...	...	1	...	...		7
3	...		...	4	1	...	...	1	...	1		12
4		2		...	...	...	1	1	...	...		7
5			2		...	3	...	2	1	...		13
6				6		...	2	1	3	...		17
7					1		...	4	3	1		25
8						3		...	2	2		24
9							5		...	2		44
10								12		...	etc.	48
									11			
										6	etc.	

III. The Died.

Age at Entry.	Ages at Exit. 1	2	3	4	5	6	7	8	9	10	etc.	Total Entrants of the Died.
1	...	...	...			...	...	...	...			...
2		...	...				...		...			...
3			1				...		...			1
4							...		...			1
5			1				...					1
6						1	1					3
7							...					1
8						1						2
9							1					5
												5

It will be observed that by this process only one numbering or counting of the cards is required—viz. those who exit. The whole of the entrants at each age in each section are gathered together without being numbered, these are then separated according to their ages at exit and numbered—the horizontal summation producing the number of entrants at each age, and the perpendicular summations the number of exitants of each age. When all these numbers are corrected for the half-year of entry, and the discontinued are corrected for the half-year of exit, the following would be the years of life exposed to mortality by each of these sections.

Age.	Years exposed to Mortality by the Living.	Withdrawn.	Died.	Total years of life exposed to Mortality.	Deaths.
1	14·	7·	...	21·	...
2	31·	16·5	...	47·5	...
3	40·5	24·	5	65·	1
4	49·	29·5	·5	79·	...
5	56·	36·	1·5	93·5	...
6	66·5	49·	3·5	119·	1
7	77·	66	4·5	147·5	1
8	99·5	82·	5·	186·5	...
9	126·5	104·5	8·5	239·5	...
10	154·	142·	13·5	309·5	1
	etc.	etc.	etc.	etc.	
Totals,	761,118·	162,211·	277,071·5	1,200,400·5	20521

The total coincides with the figures given on page 24 of the H^M Mortality Experience.

I now call your attention to the method followed in developing the H^M Experience and in obtaining the numbers exposed to the risk of Mortality in each year of age. It is described on page 18 of the preface to the first volume. As a reference is there made to the Tables of Observations I give the observations with reference to the current age at entry of 30.

Current age at Entry.
30

Total Entrants.
5791

Current age at Exit.	Existing.	Discontinued.	Died.
30	319	75	4
31	252	365	28
32	230	220	35
33	235	153	49
etc.	etc.	etc.	etc.
	3677	1491	623
		5791	

It was assumed, as stated on page 3, that lives entering at these current ages would attain to those ages, as their actual age, at the end of their years of entry. All lives thus entered are six months younger than their real age, and only attained that age, as their actual age, at the end of the year in which they entered.

'The number exposed to risk was obtained in the first year of assurance by taking half the number who entered in the year of age less half the number who discontinued in the same year. In the second year of assurance it was found by deducting from the number who entered on the second year of assurance half the number who discontinued during that year. Thus in Table of Observations in current age 30 :—

			Number exposed to risk.
1. *Number exposed during first year*—			
The total number of entrants was 5791 half of which		=2895·5	
Discontinued the first year	75 half of which	= 37·5	
Number exposed to risk in the first year,		——	2858
2. *Number exposed during the second year*—			
Number who entered on the first year,		5791	
Deduct those leaving during the first year			
Existing, ...	319		
Discontinued, . .	75		
Died, ...	4		
	——	398	
Leaving the number who entered on the second year, . .		5393	
Deduct half of the Discontinued in the second year, . .		182·5	
Number exposed to risk in the second year, .			=5210·5
3. *Number exposed during the third year*—			
Number who entered on the second year, ...		5393	
Deduct those leaving during the second year,			
Existing, ...	252		
Discontinued, . .	365		
Died, ...	28		
	——	645	
Leaving the number who entered on third year, ...		4748	
Deduct half of the Discontinued in third year, ...		110	
Number exposed to risk in the third year, .			=4638

I have taken the liberty of amplifying the expressions by adding words that seemed to me required to make the meaning more apparent.

It will be seen that the number exposed to risk during six months of the first year of assurance is half of the number (5791) who entered upon that year less half of the number (75) who discontinued in that year, that is to say the number 2858 so computed, is assumed to be exposed to risk for twelve months and of whom 4 died. The number exposed to risk during the second year of assurance is the number 5393 who entered upon the second year, less half of those (365) who discontinued in that year. This

number (5210·5) is assumed to have been on the risk for twelve months, and of whom 28 died, and so on for other years.

That is to say, the Mortality is from birthday to birthday, but the first year's rate of mortality is the ratio of the total deaths during the average period of six months to the number exposed during that same average period of six months. The method proposed by me is to ascertain the total years of life exposed to risk from the exact age at entry expressed in years and months up to the attainment of the end of that year of age, or up to the date of withdrawal in that year of age. The ratio of the total deaths in that period to the total years of life exposed is the rate of mortality in the first year of life after entry. For those who die before completing to the end of that year of age, the period of exposure will not be the fractional period of the year, but twelve months experience will be set apart for them—seeing that we are calculating the rate of mortality for "year-units."

Another method of arriving at the same results as those of the H^M table consists of a slightly different arrangement—but which appears to me to be much more expeditious. It is the method followed by me in 1863 as you may observe from the volume laid before you.

Current age at entry 30.								
Current age attained in year of exit.	Total number of lives entered on risk.	Of whom: Withdrawn.	Of whom: Died.	Of whom: Living at close of Observations.	Total of these Numbers W_{x+n} D_{x+n} L_{x+n}	Sum of these (upwards)	Half of the number entering less half the Withdrawn.	Number exposed to Mortality.
		At age in col. 1.						
$x+n$		W_{x+n}	D_{x+n}	L_{x+n}				
30	5791	75	4	319	398	...	2858·	2858·
31	...	365	28	252	645	5393	182·5	5210·5
32	...	220	35	230	485	4748	110·	4638·
33	...	153	49	235	437	4263	76·5	4186·5
34	...	147	51	198	396	3826	73·5	3752·5
*		*	*	*	*	*	*	etc. as in page 147
	Sums	1491	623	3677	5791			

There is still another arrangement of the data of Entrants of each age, and which affords information more closely related to the method I have suggested. It ascertains the quantums of the years of life derived from the three sections—the Withdrawn, the Died, and the Living. It embraces :—

1st. The years of life exposed from the Withdrawn,
2nd. The years of life exposed from the Living,
3rd. The years of life exposed from the Died, and finally,
4th. The total years of life.

But this method can only be obtained from the H^M experience by a re-arrangement of all the statistics.

These examples refer to the entrants at any one age—and the table showing the experience of the whole number may either be derived from the addition of the sectional experiences. Thus:—

	30	31	32	33	34	35
30	2858·4	5210·528	4638·35	... ..	.....	.....
31	.....	2438·10	4492·36	...	.....	.....
32	.....	.....	2345·12	.....	.....	.....
			etc.			
33	.....	.....	.....	.....	.....	.....
	27112·5(224)					
		29213·(215)				
			31232·(260)			

as in the H^M table, or as in the MS. volume before you, or the aggregate may be derived at once as follows:—

(The figures of the following illustrations as taken from some of the Scottish Experience in 1863.)

AGGREGATE NUMBER EXPOSED TO RISK OF MORTALITY AT EACH YEAR OF LIFE.

Current Age.	Entrants.	Exitants.			Sum of these.	Total Entrants at all younger ages.	Total Exitants at all younger ages.	Difference.	Allowance of half year for those entering and those Withdrawing at each age.	NUMBER EXPOSED TO RISK OF MORTALITY	Completed age.
		Withdrawn.	Died.	Living.							
1	...	...	...	...	...	...	...	...	...	...	...
2	...	...	...	...	..	...	. .	...	...	...	...
3	...	...	...	...	...	...	...	...	...	...	...
4	2	...	...	...	...	...	...	...	*1·*	1·	3
5	4	...	...	1	1	*2*	...	2	*2·*	4·	4
6	8	...	...	2	2	*6*	*1*	5	*4·*	9·	5
7	11	...	...	3	3	*14*	*3*	11	*5·5*	16·5	6
8	17	2	...	3	5	*25*	*6*	19	*7·5*	26·5	7
9	25	2	...	2	4	*42*	*11*	31	*11·5*	42·5	8
10	31	...	...	3	3	*67*	*15*	52	*15·5*	67·5	9
11	34	3	1	5	9	*98*	*18*	80	*15·5*	95·5	10
21	875	76	13	213	302	*1962*	*601*	1361	*399·5*	1760·5	20
31	3169	492	138	1255	1885	*26086*	*11059*	15027	*1338·5*	16365·5	30
41	2015	402	224	1671	2297	*53854*	*32648*	21206	*806·5*	22012·5	40
51	726	169	235	1225	1629	*67541*	*53285*	14256	*278·5*	14534·5	50
61	140	51	190	619	860	*71875*	*65588*	6287	*44·5*	6331·5	60
71	8	6	93	160	259	*72505*	*70866*	1639	*1·*	1640·	70
81	...	...	28	225	53	*72549*	*72323*	226	...	226·	80
	...	...	1	...	1	*72549*	*72544*	5	...	5·	90
	72549	12421	8810	51318	72549					627845·	

A very interesting and independent check upon the correctness of the total number exposed may be obtained by ascertaining the total of the ages at entry of the three classes separately, and also the ages at exit. Thus I take from the figures of the Males with Profits of the Scottish Experience in 1863 :—

I. LIVING.—		
Sum of the 51318 ages at entry	=1,773,792	
" " exit	=2,220,521	
Difference—years of life exposed		=446,729
II. WITHDRAWN.—		
Sum of the 12421 ages at entry	= 416,327	
" " exit	= 471,742	
Difference—years of life exposed		= 55,415
III. DIED.—		
Sum of the 8816 ages at entry	= 351,067	
" " exit	= 446,704	
Difference—years of life exposed		= 95,637
		597,781
Add—Half the difference between the total Entrants	= 72,549	
And the Withdrawn	= 12,421	
	2)60,128	= 30,064
Total years of life—which coincides with the Total years when computed in the ordinary way (as in the previous page)		=627,845

and consequently we have

Average age at entry of the Living	34·565	
" exit "	43·770	
Average term exposed of the Living		9·205
Average age at entry of the Withdrawn	33·518	
" exit "	37·979	
Average term exposed of the Withdrawn		4·461
Average age at entry of the Died	39·849	
" exit "	51·204	
Average term exposed of the Died		11,355

Average age at entry of the whole number $= \frac{2,541,186}{72,555} = 35·024$

Average age at exit of the whole number $= \frac{3,138,967}{72,555} = 43·264$

Average duration of the whole risks = 8·240

These very interesting facts are not usually supplied at Mortality Investigations. Indeed, there was no attempt whatever made to obtain them at either the experience of the Seventeen Offices or that of the H^M. table. It seems to me that they furnish a key to the maturity and to the trustworthiness of any experience, and when contrasted with the like results of other Investigations they afford a fair measure of their relative significance and weight.

We have now arrived at that very interesting stage of being able to determine the rate of mortality experience in each year of life. It is the ratio of the number dying in a year to the number of lives exposed in the same year—thus H^M table, p. 244 and p. 273:—

Age.	Number exposed to risk.	Number of Deaths.	Rate of Mortality.
10	379·	3	·00792
11	434·	...	·00000
12	491·5	2	·00407
13	578·	2	·00346
14	731·	3	·00410
15	908·	2	·00220
16	1129·	...	·00000
17	1421·	6	·00422
18	1810·5	11	·00608
19	2414·	17	·00704

and the number alive at the end of each year in a Table of Mortality is arrived at by the following additional columns:—

Age.	Probability of living a year p_x.	Log. of p_x.	Log. of Number living.	Number Living.	Deaths.
10	·99208	$\bar{1}$·99655	4·00000	10000	79
11	1·00000	·00000	3·99655	9921	...
12	·99593	$\bar{1}$·99823	·99655	9921	40
13	·99654	·99849	·99478	9881	35
14	·99590	·99822	·99327	9846	40
15	·99780		·99149	9806	22
16	1·00000		·99053	9784	...
17	·99578			9784	41
18	·99392			9743	59
19	·99296			9684	

A much more direct method of obtaining the number living in a Table of Mortality is the following:—

Age.	Number exposed to Mortality. A	Number surviving the year. B	Log. *A*.	Log. *B*.	Log. of p_x (£. *B* − £. *A*).	Log. l_x.	l_x.	$l_x - l_{x+1}$.
10	379·	376·	5786392	5751878	9965486	5·0000000	100000	792
11	434·	434·	6374897	6374897	0000000	4·9965486	99208	000
12	491·5	489·5	6915235	6897527	9982292	9965486	99208	403
13	578·	576·	7619278	7604225	9984947	9947778	98805	342
14	731·	728·	8639174	8621314	9982140	9932725	98463	404
15	908·	906·	9580858	9571282	9990424	9914865	98059	216
16	1129·	1129·	0526939	0526939	0000000	9905289	97843	000
17	1421·	1415·	1525941	1507564	9981623	9905289	97843	413
18	1810·5	1799·5	2577985	2551519	9973534	9886912	97430	592
19	2414·	2397·	3827373	3796680	9969307	9860446	96838	
	Sums	and check	£3374072	£3203825	£9829753			
20 etc.						9829753 etc.	96156	

The last two columns form the Table of Mortality of which it has been the object of this paper to describe the construction. That table embraces the probabilities of dying in each year of life derived from the several statistics applicable to these ages. But, by being continuous, that is, by making the number surviving one age to form the entrants upon the following age, Actuaries are enabled to ascertain, by one continuous stream of calculation, the number of years which persons of any age are likely to live, or the probability of one person of any age living to any other age, or the probability of one life of one age surviving another life of a different age, and many other complicate and delicate combinations of life and of death. When combined with the discount of money they are able to ascertain the capital sum which will provide an annuity during a lifetime, and the present value of a capital sum payable on surviving a given age, or on dying before attaining to that age, and thus to conduct the business of life assurance and annuities, which now constitutes so large a portion of the wealth of all well-conducted communities.

It only remains to be graduated from age to age, without interfering with its character, before being ready for practical use.

A check upon the correctness of the operations by summations is shown, which, in continuous calculations, is exceedingly valuable.

The rate of mortality experienced during the year in which the lives were entering, at, say, equal intervals throughout the year, was, in the H^M table, determined by assuming that the whole number of entrants in that year were at risk for half a year—or what is very much the same thing, by assuming that half the entrants were at risk for the whole year, and that the quotient resulting from a division of the number who died in that semi-twelve months by that number of entrants was the rate of mortality for the first year. The period was really only six months; but the deaths and the years of life for the six months were so adjusted to each other as to give the probability of dying during twelve months. When put in the form of a fraction

$$q_{x.1} = \frac{\text{Number dying during 6 months.}}{\text{Years of life exposed during 6 months.}}$$

$$= \frac{\text{Number dying during 6 months.}}{\text{Half the years of life exposed during 12 months.}}$$

Multiplying numerator and denominator by 2.

$$= \frac{\text{Double the number dying during 6 months.}}{\text{Years of life exposed during 12 months.}}$$

There would not have been much objection to this assumption, for we have all been trained to believe that the value of a fraction is unaltered when numerator and denominator are multiplied by the same quantity.

I have however deduced the rate of mortality on this changed hypothesis, *i.e.* I have doubled the deaths in the first year, and I have not halved the number who entered upon the year. I have also calculated the number remaining alive at the end of each year out of a radix of 100,000,—ascertained the number who die at each year of age—graduated that number by Woolhouse's method, and I now exhibit the difference between the number of deaths according to the two hypotheses, from which it will be seen (barring ages 10, 11, 12, 13) that fewer die up to age 54, and more at older ages,—a character of table that exacts smaller premiums at ages under 54, and larger premiums thereafter—and that requires larger values of policies all through; a table of mortality essentially different from the H^M table.

DISTRIBUTION OF THE 100000 DEATHS BY THE TWO TABLES.

	Number of deaths.		Difference	
	Table based upon doubling the deaths. *A*	Table based upon halving the number exposed. *B*.	*A* greatest.	*B* greatest.
10–14	1991	1776	215	...
15–19	1824	2001	...	177
20–24	2852	3162	...	310
25–29	2975	3196	...	221
30–34	3493	3584	...	91
35–39	3911	3997	...	86
40–44	4290	4365	...	75
45–49	5161	5193	...	32
50–54	6193	6213	...	20
55–59	7669	7647	22	...
60–64	9608	9569	39	...
65–69	11270	11173	97	...
70–74	12611	12433	178	...
75–79	11943	11761	182	...
80–84	8672	8508	164	...
85–89	4034	3962	72	...
90–94	1346	1325	21	...
95, etc.	157	135	22	...
	100000	100000	1012	1012

You will thus observe that it is a very serious business tamperi with a table of mortality. The change illustrates the superi advantages of my suggested method of finding the numb exposed by taking the difference between the exact age at ent in years and months, and the exact age at exit in years a months. In many minor ways, that I can scarcely find langua sufficiently exact to express, I observe its advantages.

Another example of tampering with numbers exposed may found in the table of Seventeen Offices' Experience. It is stat that some of the experiences were multiplied by four, and th that four-folded experience was added to the others before deduci the general results. The grounds for the alteration are not giv with such exactness as to enable me to re-explain them. It do not seem incorrect to multiply to any extent you like t numerator and denominator of the fraction that expresses t rate of mortality—the resulting quotient is unaffected by th multiplication. But when we have any total experience divide or separated into sections, and the total of these sections is t result to be aimed at, it does not appear to me to be correct t intensify any one section and leave the others alone, befo finding the average of the aggregate. If we have three separat experiences:—

$$q_x = \underset{\text{Office } A.}{\tfrac{1}{100}} + \underset{\text{Office } B.}{\tfrac{1}{90}} + \underset{\text{Office } C.}{\tfrac{1}{80}} = \underset{\text{Aggregate.}}{\tfrac{3}{270}} = \tfrac{1}{90}$$

and if the experience of Office A is multiplied by 4 and th others left alone, the aggregate experience becomes less than $\frac{1}{90}$.

Thus $$q_x = \tfrac{4}{400} + \tfrac{1}{90} + \tfrac{1}{80} = \tfrac{6}{570} = \tfrac{1}{95}$$

It seems clear that the multiplication of the experience of Office A —even although both numerator and denominator be multiplie by the same quantity—intensifies the aggregate result in th direction of the experience of Office A.

I do not enlarge any more on this point at present, furthe than to introduce to your notice the problem that I hope to hav the pleasure of discussing another evening. I lay before you th complete observations upon which the H^M table was founded There are the numbers exposed, emanating from the age at entr and passing through each subsequent age. The total deaths i each year divided by the totals passing through the same ag gives the rate of mortality at each age. Thus, taking age 40, th complete observations are:—

	Number exposed.	Deaths.	Rate of Mortality.
Entrants from age 5 passing through age 40	1·	...	·000000
,, 7 ,, ,,	1·	...	·000000
,, 8 ,, ,,	1·	...	·000000
,, 9 ,, ,,	3·	...	·000000
,, 10 ,, ,,	7·	...	·000000
,, 11 ,, ,,	3·	...	·000000
,, 12 ,, ,,	5·	...	·000000
,, 13 ,, ,,	15·	...	·000000
,, 14 ,, ,,	16·	...	·000000
,, 15 ,, ,,	18·	...	·000000
,, 16 ,, ,,	22·	..	·000000
,, 17 ,, ,,	26·	...	·000000
,, 18 ,, ,,	31·	...	·000000
,, 19 ,, ,,	46·	1	·021739
,, 20 ,, ,,	85·5	...	·000000
,, 21 ,, ,,	188·5	1	·005305
,, 22 ,, ,,	286·5	4	·013962
,, 23 ,, ,,	416·	4	·009615
,, 24 ,, ,,	657·	9	·013698
,, 25 ,, ,,	806·5	10	·012399
,, 26 ,, ,,	1013·	13	·012833
,, 27 ,, ,,	1281·	26	·020297
,, 28 ,, ,,	1506·5	15	·009957
,, 29 ,, ,,	1921·	16	·008329
,, 30 ,, ,,	1937·	20	·010325
,, 31 ,, ,,	2172·	24	·011050
,, 32 ,, ,,	2475·5	24	·009695
,, 33 ,, ,,	2729·	33	·012092
,, 34 ,, ,,	2817·	31	·011005
,, 35 ,, ,,	2968·5	37	·012464
,, 36 ,, ,,	2828·	29	·010255
,, 37 ,, ,,	3227·	29	·008287
,, 38 ,, ,,	3182·5	21	·006599
,, 39 ,, ,,	3740·	21	·005615
,, 40 ,, ,,	1762·	9	·005108
	38195·	377	(·009870)
Average, $\frac{\cdot 230629}{35} = \underline{\cdot 006589}$			

Of all these various rates of mortality of persons passing through the year of life 40–41, the question I have propounded to myself is—Which is the most probable? I do not think it is the $\frac{377}{38195}$ ·009870, because, however much the deaths and exposures be interchanged, the above result would remain the same. Thus, if the deaths among the last twenty-five exposures were reversed, the summations would still remain at $\frac{377}{38195}$, but to my mind the most probable rate of mortality would in these changed circumstances be very different. It may be that it is the mere numerical magnitude of the observations that affects the result. It may be that it is the force of selection that lessens the

average and creates the most probable. It may be that I have ir ported a small measure of heresy into the solution of the proble But in a table which is to embody the several experiences ar incorporate them into one average rate, for such a "going concerr as an Insurance Office involving new insurances as well as o insurances, it seems to me that due weight should be given to t magnitude of the experiences—the numbers exposed and tl number of their deaths—and that we should not take the me summations as the only factors for determining the rate mortality in an aggregate table.

To this problem I hope to have the pleasure of drawing yo attention on a subsequent evening.

On a mode of graduating a Table of Mortality

BY

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On a mode of graduating a Table of Mortality

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GRADUATION of all kinds is most attractive. The highest mathematical minds have apparently lingered upon it with delight, and when I glance down the weighty list, I feel that I, of all persons, should have shrunk from touching it. Most of these men have treated the subject in a highly theoretical manner, and have furnished formulæ that are extremely difficult to apply. A few, however, have followed in their footsteps and elaborated something that is practical. Other enthusiasts have searched for and have thought that they had found a 'Law of Mortality.' Some are still searching for it, and more will continue the search in all time coming. A Law of Mortality seems to me to be as illusive as the rainbow. The law found is only the law of some mathemathical process of summation.

The method of graduation indeed should vary with the matter to be graduated. When applied to the probability curve, it is intensely fascinating, and there appears to me to be occasional opportunities in our business of so applying it. I do not profess to put forward any new scheme. I do not propose to electrify the subject. I possess no wizard's wand. All I propose to do is to elaborate a very simple exposition of the most elementary principles on the subject of differences, but I am bold enough to state that, in my opinion, it is all that is necessary in the graduation of a table of mortality.

Having ascertained for each year of age the Ratio of the number of deaths to the number of persons exposed to the Risk of Mortality, usually termed the Rate of Mortality or the probability of dying, and having ascertained from that probability the further probability of surviving from year to year, and having formed the continued product of these surviving probabilities, and thus ascertained the numbers remaining alive at the end of each year of age out of any fundamental radix of numbers entering upon the youngest age, this continued product is termed a Table of Mortality. It exactly reflects the facts of the original experience, because it will be observed that the difference between the number who enter the table at the beginning of any year of

life, and the number who survive the same year, when divided b the number who enter, exactly repeats the rate of mortalit derived from the fundamental facts. Thus, at the age 35.

I. By the Table.

Number entering that year of life = 86255
" surviving " " = 85544
Number dying in the year, . . . $\frac{711}{86255} = \cdot 00824$ = Ra of Mortalit
Divided by the number entering, . .

II. By the original facts, p. 244, vol. i.

Number dying in year of age 35-36 = $\frac{295\cdot}{35818\cdot 5} = \cdot 00824$ = Rate Mortalit
Number exposed to risk = 35818·5

and so on from age to age. So that by the device of forming radix of 100,000 at the youngest age, and by applying the su cessive probabilities of living from age to age, we repeat an reflect the actual incidents of the original facts. This device the radix is essential to all our calculations. By its aid we pa from the numbers at any one age to the numbers at any oth older age, and determine the probability of living over the inte vening years; and by incorporating with that probability th present value of £1 payable certainly at the end of these yea we are enabled at once to ascertain the present value of a Endowment of £1 payable upon the contingency of the life su viving that term. This is the initial problem of all Actuari calculation. Thus to take a simple illustration—at 4 per cent.

1. Value of $v^5 \frac{l_{40}}{l_{35}}$ by the table $= \frac{\cdot 821927 \times 82230}{86255} = \cdot 78359.$

2. Value by the original facts—

$$\frac{\cdot 821927 \times 35523\cdot 5 \times 36514\cdot 5 \times 37013 \times 37415\cdot 5 \times 37707}{35818\cdot 5 \times 36840\cdot 5 \times 37360 \times 37804\cdot 5 \times 38112}$$
$$= \cdot 7835$$

The brevity of the calculation when performed by aid of th table of mortality based upon a radix is thus manifestly apparen The calculation of the present value of an Annuity of £1 payab during life, or the present value of a sum of £1 payable at deat would be almost insurmountable if the figures of the original fac were to be strictly adhered to.

While the calculations framed upon the device of the radix a practically equivalent to the calculations formed upon the origin data, it is essential, for the consistent prosecution of all our calc lations, that the rate of mortality derived from the original fac

be adjusted and smoothed from age to age, that it shall give effect to the broad and natural law (the only law of mortality) that the rate of mortality of an older life is always greater than the rate of mortality of a younger life. This law is manifest in the original facts when the ages of the two lives are widely apart, and when the facts are numerous, but it is not always apparent when both lives are young, or when both lives are old—a result entirely owing to the paucity of the facts at these ages. Thus the facts declare that the rate of mortality of persons of

Age 30	is greater than	the mortality	of persons	age 20
„ 40	„	„	„	30
„ 50	„	„	„	40
„ 60	„	„	„	50

and so on.

But when the facts are few in number it is sometimes observed that the mortality of persons of

Age 20	is less than	the mortality	of persons	of age 19
„ 21	„	„	„	20
„ 24	„	„	„	23
„ 25	„	„	„	24

and so on.

These lesser facts must, however, yield to the major, and we are accordingly forced to construct our table upon the footing that mortality increases with the age. It is thus essential that the rough results derived from the original facts be placed under some process of adjustment and graduation for the purpose of correcting these minor irregularities. But it is also essential that this adjustment shall not disturb the character and value of the original data. A new table is by no means to be prepared. The graduated table must submit to the test of reproducing the total original number of deaths out of the original numbers exposed. This process of adjustment it shall be my endeavour this evening to describe. There are many modes of preparing this adjustment. The one I have the honour of laying before you is simply another. I do not claim for it that it is superior to all others. Each method probably has its own special merits, but that method which combines the greatest degree of smoothness with the least disturbance of the broad original facts is in my opinion the best, and ought to be preferred.

The H^M table was graduated by the method known as Woolhouse's method, and seeing that some of the details of this method do not appear to me to be sufficiently understood, or its merits adequately apprehended, I have thought that it would be agreeable to you that I should point out by a few examples its general

scheme. It is fully described in the *Assurance Magazine*. It consists generally of taking the average of n interpolations drawn through the rough results n terms apart. Woolhouse adopted n equal to 5. He thus derived five new sets of figures, each set being based upon the individual rough results at each fifth age. The average of these five sets is his final result. On paper it seems beautifully conceived, but when we look at the final result of this beautifully conceived problem many imperfections are obvious from which the table requires to be corrected.

Some other writers whose names I cannot recall have simplified Woolhouse's method of computation without altering his results, and inasmuch as this altered method is the one generally followed when applying Woolhouse's principles I shall follow it.

Let it be required to graduate by Woolhouse's principles the following figures in col. A taken from the table page 273 of vol. i. of the H^M Mortality Experience.

Central Age.	Contiguous Ages.	Gross results to be graduated upon a radix of 10,000.	Factor of graduation.	Product negative.	Product positive.	
...	23	73	× − 3	−219	...	
...	24	64	× − 2	−128	...	
...	25	48	× − 0	− 0	...	
...	26	64	× +3	...	+ 192	
...	27	60	× +7	...	+ 420	
...	28	71	× +21	...	+1491	
...	29	67	× +24	...	+1608	
30	...	74	× +25	...	+1850	
...	31	65	× +24	...	+1560	
...	32	74	× +21	...	+1554	
...	33	73	× + 7	...	+ 511	
...	34	76	× + 3	...	+ 228	
...	35	71	× + 0	...	+ 0	
...	36	75	× − 2	−150	...	
...	37	81	× − 3	−243	...	
			Sums (125)	−740	+9414	
			Deduct .	.	− 740	
			Net sum positive =		+8674	=69·392 upon a radix of 10,000
			Divided by 5^3 =		125	

and accordingly 694 appears at age 30 in the table (page xciv. vol. ii.) upon a radix of 100,000.

The foregoing process when written algebraically is

$$d_{\frac{1}{30}}=\tfrac{25}{125}d_{30}+\tfrac{24}{125}(d_{29}+d_{31})+\tfrac{21}{125}(d_{28}+d_{32})+\tfrac{7}{125}(d_{27}+d_{33})+\tfrac{3}{125}(d_{26}+d_{34})-\tfrac{2}{125}(d_{24}+d_{36})-\tfrac{3}{125}(d_{23}+d_{37})5d_{\frac{1}{30}}=\tfrac{120}{125}d_{30}+\tfrac{120}{125}(d_{29}+d_{31})+\tfrac{105}{125}(d_{28}+d_{32})+\tfrac{35}{125}(d_{26}+d_{33})+\tfrac{15}{125}(d_{26}+d_{34})-\tfrac{10}{125}(d_{24}+d_{36})-\tfrac{15}{125}(d_{23}+d_{37})=d_{30}+\cdot 96(d_{29}+d_{31})+\cdot 84(d_{28}+d_{32})+\cdot 28(d_{27}+d_{33})+\cdot 12(d_{26}+d_{34})-\cdot 08(d_{24}+d_{36})-\cdot 12(d_{23}+d_{37})$$

which is identical with the formula on page xc. of vol. ii.

The more popular method of arriving at the same result by the summation is (2^5 means col. 2 summed in five):

	Number of deaths to be graduated.	2^5_5	$(2^5_5)^2$	$(2^5_5)^3$	$9+(2^5_5)$	A	$2\frac{1}{5}A$	$3\cdot\frac{1}{5}A=B$	$A-B$	$\frac{A-B}{125}=$	Graduated result.
23	73	311	1570	7792	2799	10591	871	2613	7978·	63·828	
24	64	308	1554	7809	2772	10581	936	2808	7773·	62·184	
25	48 =	309 =	1545 =	7838	2781	10619	969	2907	7712·	61·696	
26	64 =	307	1570	7909	2763	10672	988	2949	7723·	61·784	
27	60	310	1599	8042	2790	10832	991	2973	7859·	62·872	
28	71	336	1641	8236	3024	11260	1006	3018	8242·	65·936	
29	67	337	1687	8428	3033	11461	1014	3042	8419·	67·352	
30	74	351	1739	8623+	3159=	11782	1036	3108	8674·	69·392	
31	65	353	1762	8801	3177	11978	1050	3150	8828·	70·624	
32	74	362	1794	8970	3258	12228	1074	3222	9006·	72·048	
33	73	359	1819	9127	3231	12358	1107	3321	9037·	72·296	
34	76	369	1856	9314	3321	12635	1128	3384	9251·	74·008	
35	71	376	1896	9522	3384	12906	1155	3465	9441·	75·528	
36	75	390	1949	9757	3510	13267	1168	3504	9763·	78·104	
37	81	402	2002	9990	3618	13608	1194	3582	10026·	80·208	

The foregoing is a section of the complete process for the whole table.

The process of summation is easily generalised. Indeed the relations between this method and a method suggested by Finlaison may be easily shown:

		60	71	67						
			71	67	74					
			71	67	74					
				67	74	65				
				67	74	65				
				67	74	65				
					74	65	74			
					74	65	74			
						65	74	73		
Sum	=	60	213	402	518	390	222	73	=	$\frac{1478}{27}=54\cdot741$
Number		1	3	6	7	6	3	1		(Finlaison.)
Add				9	9	9				
		1	3	15	16	15	3	1		
Deduct	3	3	3	3	3	3	3	3	3	
	−3	−2	0	12	13	12	0	−2	−3	÷27 = 57·333 (Woolhouse.)

Proceeding in a similar manner it may be shown that Woolhouse's method, when the central age is the centre of the following terms:

Number of steps.	Number of terms.																								
3	9																								

The beauty of the method lies in the fact that the summation of adjusted numbers exactly equals the summation of the unadjusted numbers; but that agreement is its single excellence. The results when the central age is the centre of five are not possessed of that sweet smoothness which we would desire. They are also spread over seven terms beyond the origin at age 10, and seven terms beyond the ultimate age at age 96—at both of which ends there are several negative terms. The figures graduated commence at age 10, but the process implies that the figures at younger ages are all nothings, whereas there were several figures in the experience at younger ages that might have been included. The scale adopted was steps of five. If the graduation had been cast in steps of three the graduated results would have been unbearable. If in steps of seven the results would have been improved—in steps of nine, better, and in steps of eleven still better—and there were no fundamental reasons against either of these steps being adopted. The equations with either of these steps would equally with steps of five, have been linear equations. There was, however, an advantage in adopting steps of five which is not readily observed. It is a part of the process that certain figures are to be divided by the cube of the number of steps.

If graduated in steps of	three	the divisor is	$3^3 =$	27
" "	five	"	$5^3 =$	125
" "	seven	"	$7^3 =$	343
" "	nine	"	$9^3 =$	729
" "	eleven	"	$11^3 =$	1331

but you will observe that dividing by 125 is effected by the easier operation of multiplying by ·008. while dividing by any of the others cannot be performed by any similarly simple operation. So much for the process. The obvious irregularities of the results so brought out were corrected. The most apparent instances of unsmoothness were performed by a very neat process described in his papers. The results of assuming figures at all ages younger than age 10 as nothings were also corrected. But these corrections however beautifully effected are, to my mind, confessions of imperfections.

I have a fundamental objection to any graduation which strictly recognises the exactness of the original facts at the several individual ages. The facts probably declare that one death occurred out of two exposed. But I cannot acquiesce in the arithmetical deduction because one died out of two that 50,000 will die out of 100,000, or that the probability of dying in that year is ·5.

I have faithfully repeated Woolhouse's method performed in steps of three, five, seven, nine and eleven, and beg to annex them. I also annex an epitome of the number of deaths in each five years of age.

NUMBER OF DEATHS IN EACH FIVE YEARS WHEN THE TABLE IS GRADUATED IN STEPS OF THREE, FIVE, SEVEN, NINE OR ELEVEN YEARS.

	By the unadjusted Table.	Number of Steps of Graduation.									
		Three.		Five.		Seven.		Nine.		Eleven.	
		Deaths.	Deviation from the facts.	Deaths.	Deviation.	Deaths.	Deviation.	Deaths	Deviation.	Deaths.	Deviation.
10-15	1941	1866	75	1776	165	1643	298	1733	208	1857	84
15-20	1903	1789	114	2001	98	2279	376	2351	448	2361	458
20-25	3188	3320	132	3162	26	2992	196	2888	300	2829	359
25-30	3093	3124	31	3196	103	3262	169	3279	186	3260	167
30-35	3620	3572	48	3584	36	3584	36	3595	25	3612	8
35-40	4025	4038	13	3997	28	3984	41	3987	38	4007	18
40-45	4301	4264	37	4365	64	4435	134	4489	188	4542	241
45-50	5185	5197	12	5193	8	5203	18	5250	65	5311	126
50-55	6117	6095	22	6213	96	6274	157	6332	215	6407	290
55-60	7644	7626	18	7647	3	7706	62	7796	152	7833	189
60-65	9669	9649	20	9569	100	9525	144	9464	205	9462	207
65-70	11385	11331	54	11173	212	11134	251	11052	333	10914	471
70-75	12460	12553	93	12433	27	12191	269	11901	559	11558	902
75-80	11548	11809	261	11761	213	11465	83	11048	500	10629	919
80-85	8510	8789	279	8508	2	8313	197	8158	352	7992	518
85-90	3908	3652	256	3962	54	4249	341	4473	565	4679	771
90-95	1357	1303	54	1325	32	1479	122	1733	376	2032	675
95-100	146	23	123	135	11	278	132	429	283	613	467
100-105						4	4	42	42	102	102
Totals,	100,000	100,000	1642	100,000	1278	100,000	3030	100,000	5040	100,000	6972

It has been stated that the degree of smoothness increased with the number of steps. Such a statement is quite natural. The graduation in steps of three is too near to the ungraduated original facts to be accepted as a smooth graduation. The best of the whole is the graduation in steps of five—because the sum of the positive and negative deviations from the facts is only 1278.

While the sum of the differences when graduated in steps of seven = 3030
" " " " nine = 5040
" " " " eleven = 6972

as shown above. The effect of increasing the range of the steps is to increase the magnitude of the undulations, which may be observed by casting the eye along the horizontal progress of the same differences.

I give another example of the tendency of the process adopted by Woolhouse.

EXPECTATION OF LIFE WHEN THE PROCESS OF GRADUATION IS PERFORMED IN STEPS OF

Age.	From original facts, p. 287.	Five.	Seven.	Difference.	Nine.	Difference.	Eleven.	Difference.
10	50·29	50·291	50·314	·023	50·320	·029	50·326	·035
15	46·24	46·161	46·111	·050	46·161	·0	46·229	·068
20	42·09	42·061	42·143	·082	42·229	·168	42·310	·249
25	38·44	38·405	38·415	·010	38·460	·055	38·520	·115
30	34·68	34·681	34·718	·037	34·772	·091	34·828	·147
35	31·03	31·016	31·055	·039	31·117	·101	31·182	·166
40	27·42	27·399	27·436	·037	27·504	·105	27·580	·181
45	23·79	23·792	23·855	·063	23·945	·153	24·046	·254
50	20·30	20·306	20·386	·080	20·495	·189	20·626	·320
55	16·93	16·962	17·070	·108	17·211	·249	17·376	·414
60	13·80	13·830	13·974	·144	14·165	·335	14·391	·561
65	11·01	11·012	11·184	·172	11·413	·401	11·697	·685
70	8·54	8·495	8·715	·220	9·008	·513	9·648	1·153
75	6·42	7·376	6·646	·270	6·998	·622	7·394	1·018
80	4·71	4·719	5·024	·305	5·399	·680	5·816	1·097
85	3·51	3·511	3·789	·278	4·158	·647	4·558	1·047
90	2·35	2·357	2·751	·494	3·147	·790	3·526	1·169
95	1·21	·930	1·684	·754	2·209	1·279	2·581	1·651
100	...	·0	·5	·500	·738	·738	·789	·789

While Woolhouse's selection of five steps in the graduation coupled with his minor adjustments of obvious irregularities fairly repeats the results of original facts, it is obvious that the process, as a process, very seriously tends to produce a table which differs materially from that forecast by the original data. The expectations of our future lifetimes would thus appear to be in some measure regulated by the peculiarities of mathematicians.

	Ungraduated.		Steps of Three.		Steps of Five.		Steps of Seven.		Steps of Nine.		Steps of Eleven.	
	Living.	Deaths.	Living.	Deaths.	Living.	Deaths.	Living.	Deaths.	Living.	Deaths.	Living.	Deaths.
61	57146	1837	57373	1736	57121	1747	56883	1755	56561	1758	56220	1761
62	55288	1858	55487	1886	55293	1828	55050	1833	54735	1826	54393	1827
63	53374	1914	53542	1945	53376	1917	53142	1908	52839	1896	52500	1893
64	51379	1995	51528	2014	51376	2001	51157	1985	50873	1966	50542	1958
65	49314	2065	49460	2068	49297	2079	49113	2044	48836	2037	48519	2023
66	47166	2148	47329	2131	47162	2135	47002	2111	46720	2116	46437	2082
67	44962	2204	45116	2213	44963	2199	44824	2178	44561	2159	44301	2136
68	42758	2204	42805	2311	42720	2243	42593	2231	42348	2213	42113	2188
69	40394	2364	40443	2362	40446	2274	40314	2279	40082	2266	39880	2233
70	37929	2465	38129	2314	38139	2307	37979	2335	37764	2298	37605	2275
71	35804	2125	35944	2185	35756	2383	35601	2378	35429	2355	35303	2302
72	33577	2227	33647	2297	33330	2426	33162	2439	33048	2381	32983	2320
73	30901	2676	31186	2461	30827	2503	30708	2454	30652	2396	30659	2324
74	28467	2434	28353	2833	28273	2554	28248	2460	28259	2393	28342	2317
75	25469	2998	25576	2777	25695	2578	25788	2460	25883	2376	26047	2295
76	23067	2402	22849	2727	23168	2527	23347	2441	23535	2348	23790	2257
77	20610	2457	20461	2389	20694	2474	20958	2389	21233	2302	21583	2207
78	18369	2241	18139	2322	18330	2364	18639	2319	19015	2218	19441	2142
79	16113	2256	15928	2211	16074	2256	16427	2212	16870	2145	17381	2060
80	13921	2192	13767	2161	13939	2135	14323	2104	14835	2035	15418	1963
81	11962	1959	11699	2068	11919	2020	12342	1981	12921	1914	13567	1851
82	10050	1912	9774	1925	10036	1883	10511	1831	11140	1781	11835	1732
83	8319	1731	7930	1844	8317	1719	8841	1670	9501	1639	10232	1603
84	6598	1721	6341	1589	6772	1545	7340	1501	8012	1489	8760	1472
85	5411	1187	4978	1363	5426	1346	6010	1330	6677	1335	7426	1334
86	4241	1170	3912	1066	4288	1138	4844	1166	5498	1179	6230	1196
87	3319	922	3013	899	3347	941	3850	994	4470	1028	5168	1062
88	2596	723	2273	740	2574	773	3020	830	3586	884	4238	930
89	1858	738	1722	551	1959	615	2328	692	2835	751	3433	805
90	1503	355	1326	396	1464	495	1761	567	2204	631	2747	686
91	1157	346	1019	307	1056	408	1301	460	1686	518	2168	579
92	796	361	675	344	728	328	939	362	1267	419	1685	483
93	438	358	337	339	474	254	662	277	932	335	1289	396
94	146	292	110	227	278	196	446	216	672	260	969	320
95	146	0	23	87	136	142	282	164	471	201	715	254
96	104	42	21	2	53	83	169	113	319	152	516	199
97	...	104	12	9	13	40	93	76	208	111	362	154
98	...	...	...	12	...	13	48	45	129	79	245	117
99	...	...	...	...	...	...	20	28	77	52	161	84
100	...	...	...	...	...	...	4	16	42	35	102	59
101	...	...	...	...	...	...	...	4	20	22	59	43
102	...	...	...	...	...	...	...	...	8	12	30	29
103	...	...	...	...	...	...	...	...	2	6	12	18
...	...	...	...	...	...	...	...	...	...	2	1	11
...	...	...	...	...	...	...	...	...	...	...	...	1

Another important test of the rate of mortality deduced by Woolhouse's method of graduation—taken in steps of five—is to re-apply the graduated q_x to the original number exposed. The result is fairly satisfactory. The following are the results of the calculation.

Comparison of Actual Deaths with Recomputed Deaths.

I.—Grouped in Fives.

Ages.	Number of recomputed deaths.	Actual number of deaths.	Difference. Actual deaths.	
			Greater.	Less.
10-14	8·924	10	1·076	...
15-19	34·335	36	1·665	...
20-24	225·750	232	6·250	...
25-29	671·285	659	...	12·285
30-34	1,260·635	1,273	12·365	...
35-39	1,757·365	1,772	14·635	...
40-44	2,009·379	1,980	...	29·379
45-49	2,212·795	2,209	...	3·795
50-54	2,302·093	2,271	...	31·093
55-59	2,326·387	2,334	7·613	...
60-64	2,286·335	2,312	25·665	...
65-69	2,005·948	2,040	34·052	...
70-74	1,621·670	1,609	...	12·670
75-79	1,072·436	1,054	...	18·436
80-84	525·607	527	1·393	...
85-89	160·000	160	...	...
90-94	35·585	36	·415	...
95-99	3·863	3	...	·863
Sums, . .	20,520·392	20,517	105·129	108·521
Difference,	3·392	...	3·392	...

II.—Grouped in Fifteens.

Under 20	43·259	46	2·741	...
20-34	2,157·670	2,164	6·330	...
35-49	5,979·539	5,961	...	18·539
50-64	6,914·815	6,917	2·185	...
65-79	4,700·054	4,703	2·946	...
80-	725·055	726	·945	...
Sums, . .	20,520·392	20,517	15·147	18·539
Difference,	3·392	...	3·392	...

These calculations point out that Woolhouse's method in steps of five, with all his emendations and corrections incorporated, fairly presented the substance of the original facts; but while that is so I am clearly of opinion that the method is not the one that is most applicable to our requirements. One curve passing through each seventh year, or even each tenth year, adjusted in the form I shall hereafter point out, would have been freer of those minor irregularities which have been deemed absolutely necessary to be corrected.

Before parting with Woolhouse's method I add a few more examples, applied to some simple figures.

Original facts.	Graduated results.	Original facts.	Graduated results.	Original facts.	Graduated results.	Original facts.	Graduated in steps of 3.	Graduated in steps of 5.	Graduated in steps of 7.
									− ·008
									− ·023
									− ·038
	− ·024		− ·024		− ·024			− ·024	− ·044
	− ·040		− ·256		− ·040			− ·064	− ·029
	− ·040		− ·184		− ·040			− ·104	+ ·073
	− ·016		− ·016		− ·232		− ·111	− ·120	+ ·218
	+ ·040		+ ·256		− ·104		− ·296	− ·080	+ ·434
	+ ·232		+ ·736		+ ·232		− ·481	+ ·272	+ ·711
	+ ·440		+ 1·952		+ ·656		− ·222	+ ·792	+ 1·032
1	+ ·640	1	+ 2·368	1	+ 1·144	1	+ ·518	+ 1·432	+ 1·370
1	+ ·808	10	+ 2·608	1	+ 2·320	2	+ 2·370	+ 2·120	+ 1·691
1	+ ·920	1	+ 2·648	1	+ 2·648	3	+ 4·111	+ 2·760	+ 1·793
1	+ ·808	1	+ 2·320	10	+ 2·608	4	+ 5·407	+ 2·728	+ 1·807
1	+ ·640	1	+ 1 144	1	+ 2·368	5	+ 3·926	+ 2·408	+ 1·708
	+ ·440		+ ·656		+ 1·952		+ 1·778	+ 1·848	+ 1·504
	+ ·232		+ ·232		+ ·736		− ·629	+ 1·120	+ 1·213
	+ ·040		− ·104		+ ·256		− ·815	+ ·320	+ ·860
	− ·016		− ·232		− ·016		− ·555	+ ·024	+ ·480
	− ·040		− ·040		− ·184			− ·136	+ ·277
	− ·040		− ·040		− ·256			− ·176	+ ·117
	− ·024		− ·024		− ·024			− ·120	+ ·009
									− ·049
									− ·064
									− ·044
Sums 5	5·	14	14·	14	14·	15	15·	15·	15·

These sufficiently illustrate the practical results of his process. There is, most assuredly, a very apparent symmetry about it, but as to its appropriateness to the graduation of a table of mortality that is a different matter. I conclude with another example. The rough facts are those of some probability curve, where it is most desirable to preserve the figures showing the maximum height of the apex of the curve.

ANOTHER PROCESS OF GRADUATION.

The process of graduation which I have now the honour to lay before you is based upon the numbers alive in the Table of Mortality deduced from the original data. The table is, as has been explained, the continued product of the radix, into the probability of living over each age of life, viz.—

$$l_x \quad = \text{radix}$$
$$l_x \times p_x \quad = l_{x+1}$$
$$l_{x+1} \times p_{x+1} = l_{x+2}$$

and so on;

from which we have at every tenth age

$$l_x$$
$$l_{x+10}$$
$$l_{x+20}$$
$$l_{x+30},$$

etc.

or as in the H^M table, vol. i., page 273—

	Deaths.
$l_{10} = 100000$	
	3840
$l_{20} = 96160$	
	6290
$l_{30} = 89870$	
	7640
$l_{40} = 82230$	
etc.	etc.

It appears to my way of looking at the question that all we require is to interpolate figures between these fixed points, and repeat the same fixed numbers at each decennial age in the adjusted series as they appear in the rough. It seems to me to be immaterial whether we fix upon every seventh age or every tenth age. I am merely illustrating a process. Every fifth age might too closely repeat the sinuosities of the original facts. I have for my present purpose selected every tenth age, believing that the numbers at these points would amply maintain the original character of the facts. You will also observe that by adhering to fixed points in the l_x column, the same number of deaths in each ten years is reproduced in the adjusted series, that is if I were required to interpolate the above series.

		Deaths.
viz., $l_{10}=$	100000	
		3840
$l_{20}=$	96160	
		6290
$l_{30}=$	89870	
		7640
$l_{40}=$	82230	
	etc.	

the whole of these figures would be repeated in the adjusted series.

Another character of my process is to interpolate the logarithms of the numbers. You will see as I go on that it is a very much simpler process when finding the nth power or the nth root of any number, to work with the logarithms of the numbers than with the numbers themselves. Another advantage of employing logarithms is that I have only one conversion from logarithms to numbers at the very last stage of the work. Another advantage of adhering to logarithms is that we need not be so particular with the difference between logarithms and their complements. The transition from the one to the other is done at sight.

We all know that the ordinary formula for the interpolation of a series of numbers is

$$U_{x+n}=U_x+n\Delta U_x+\frac{n(n-1)}{1\cdot 2}\Delta^2 U_x+\text{ etc.}$$

and if n become $\frac{n}{r}$ and using the symbol Y_{x+n} in place of log. U_{x+n} or colog. U_{x+n} we will have

$$Y_{x+n}=Y_x+\frac{n}{r}\Delta^1+\frac{n}{r}\frac{\left(\frac{n}{r}-1\right)}{1.\ 2}\Delta^2+\frac{n}{r}\frac{\left(\frac{n}{r}-1\right)\left(\frac{n}{r}-2\right)}{1.\ 2.\ 3}\Delta^3+\text{ etc.}$$

If we used the above formula as it is written the labour would be exhausting. In place, however, of using the differences of the series, let the values of these differences in terms of the originals be retained. Thus—

$$\Delta^1 Y_x=Y_{x+r}-Y_x.$$
$$\Delta^2 Y_x=Y_{x+2r}-2Y_{x+r}+Y_x.$$
$$\Delta^3 Y_x=Y_{x+3r}-3Y_{x+2r}+3Y_{x+r}-Y_x.$$
$$\Delta^4 Y_x=\text{ etc.}$$

Inserting these values in the original equation, and expressing it in the ascending powers of n, we get

$$Y_{x+n}=Y_x+\frac{n}{r}(Y_{x+r}-Y_x).$$

$$+\frac{n}{r}\frac{\left(\frac{n}{r}-1\right)}{1\cdot 2}(Y_{x+2r}-2Y_{x+r}+Y_x).$$

$$+\frac{n}{r}\cdot\frac{\left(\frac{n}{r}-1\right)\left(\frac{n}{r}-2\right)}{1\cdot 2\cdot 3}(Y_{x+3r}-3Y_{x+2r}+3Y_{x+r}-Y_x).$$

$$+\text{ etc.}$$

$$=Y_x-1+\frac{n}{r}\cdot\frac{Y_x}{Y_{x+r}}.$$

$$+\frac{n}{r}\frac{\left(\frac{n}{r}-1\right)}{1\cdot 2}\left(\frac{Y_{x+r}{}^2}{Y_{x+2r}-Y_x}\right).$$

$$+\frac{n}{r}\frac{\left(\frac{r}{r}-1\right)\left(\frac{n}{r}-2\right)}{1\cdot 2\cdot 3}\left(\frac{Y_x\cdot Y_{x+2r}{}^2}{Y_{x+3r}\cdot Y_{x+r}{}^3}\right).$$

$$=Y_x\frac{n^3-6n^2r-11nr^2}{6r3}+Y_{x+r}\frac{-n^3+5n^2r-6nr^2}{2r^3}+Y_{x+2r}$$

$$\left(\frac{n^3-4n^2r+3nr^2}{2r3}\right)+Y_{x+3r}\frac{-n^3+3n^2r-2nr^2}{6r3}$$

$$=n^3.\frac{Y_x\frac{1}{6r3}.Y_{x+2r}\frac{3}{6r3}}{Y_{x+r}\frac{3}{6r3}.Y_{x+3r}\frac{1}{6r3}}+n^2\frac{Y_{x+r}\frac{15r}{6r2}.Y_{x+3r}\frac{3r}{6r2}}{Y_x\frac{6r}{6r2}.Y_{x+2r}\frac{12r}{6r2}}+n\frac{Y_x\frac{11r2}{6r}.Y_{x+2r}\frac{9r2}{6r}}{Y_{x+r}\frac{18r2}{6r}.Y_{x+3r}\frac{2r2}{6r}}$$

$$=n^3\left(\frac{Y_x\cdot Y_{x+2r}3}{Y_{x+r}3\cdot Y_{x+3r}}\right)\frac{1}{6r}3+n^2\left(\frac{Y_{x+r}15\cdot r\cdot Y_{x+3r}3r}{Y_x6r\cdot Y_{x+2r}12\cdot r}\right)\frac{1}{6r}3$$

$$+n\frac{Y_x11r^2\cdot Y_{x+2r}9r^2}{Y_{x+r}18r^2\cdot Y_{x+3r}2r^2}\ \frac{1}{6r}3.$$

I have limited the algebraical expansion of the process to three terms, in order that the student may not be overwhelmed at the first, but I have developed it for several other terms, and have practically applied it to six and to eight terms. You will observe that where r is fixed at 10 the expression can be put in the form of

$$\text{Log. } Y_{x+n}=n^3A+n^2B+nC \text{ or}$$
$$\therefore\ Y_{x+n}=10^{n^3A+n^2B+nC}.$$

To give a simple example.

Take the first four terms of the H^M table

$l_{10}=10000$	Log. $l_{10}=4{\cdot}0000000$
$_{20}=\ 9616$	$_{20}=3{\cdot}9829945$
$_{30}=\ 8987$	$_{30}=3{\cdot}9536147$
$_{40}=\ 8223$	$_{40}=3{\cdot}9150303$

	Deaths.		Δ^1.
$l_{10}=100000$			
$l_{11}=$ 99758	242		35
$l_{12}=$ 99481	277		33
$l_{13}=$ 99171	310		32
$l_{14}=$ 98829	342		31
$l_{15}=$ 98456	373		30
$l_{16}=$ 98053	403		30
$l_{17}=$ 97620	433		27
$l_{18}=$ 97160	460		27
$l_{19}=$ 96673	487		26
$l_{20}=$ **96160**	513	3820	24
$l_{21}=$ 95623	537		24
$l_{22}=$ 95062	561		22
$l_{23}=$ 94479	583		21
$l_{24}=$ 93875	604		20
$l_{25}=$ 93251	624		19
$l_{26}=$ 92608	643		18
$l_{27}=$ 91947	661		16
$l_{28}=$ 91270	677		16
$l_{29}=$ 90577	693		14
$l_{30}=$ **89870**	707	6290	14
$l_{31}=$ 89149	721		12
$l_{32}=$ 88416	733		11
$l_{33}=$ 87672	744		10
$l_{34}=$ 86918	754		10
$l_{35}=$ 86154	764		8
$l_{36}=$ 85382	772		8
$l_{37}=$ 84602	780		5
$l_{38}=$ 83817	785		6
$l_{39}=$ 83026	791		5
$l_{40}=$ **82230**	796	7640	

The above work seems formidable, but when it is pointed out that the whole of it, after the differences have once been ascertained and checked, can be worked out by Burrough's Arithmoter, two-thirds of the labour difficulties disappear.

Again, the foregoing is a process of determining the interpolated l_{x+n}'s. But the interpolated ${}_1p_{x+n}$'s can as simply be worked out by determining constants from the values of the function

$$\text{Log. } p_{x+n}=\text{Log.}\frac{l_{x+n+1}}{l_{x+n}},$$

and repeating the processes of check and of difference, and thus

of compiling a table of the logarithms of p_x can be developed, so that

$$\text{Log. } p_{x+n}=n^2A+nB+C$$
$$\therefore\ p_{x+n}=10^{n^2A+nB+C}$$

and if there were a further actuarial function, so that

$$p'_{x+n}=\frac{p_{x+n}}{p_{x+n}-1}$$

a similar process would develop it.

Again—if it were desired to graduate so as to make the sum of the *numbers alive* in the rough and in the adjusted series equal, a precisely similar process would be followed.

So much for my process. Practically I have applied the process to the development of the whole life—with profit—experience of the new O^M table from age 10 to age 100. To do this in one equation of ten terms was almost within reach, but meantime I have limited it to two stages of six terms each—two of them overlapping.

The first stage was an interpolation of the following first six terms

$$\begin{aligned}
\text{Log. } l_{10} &= 5{\cdot}0000000\\
\text{,, } l_{20} &= 4{\cdot}9817886\\
\text{,, } l_{30} &= 4{\cdot}9610152\\
\text{,, } l_{40} &= 4{\cdot}9292275\\
\text{,, } l_{50} &= 4{\cdot}8791511\\
\text{,, } l_{60} &= 4{\cdot}7902942
\end{aligned}$$

by the following formula

$$n^5\frac{Y_{10}^{1}\cdot Y_{30}^{10}\cdot Y_{50}^{5}}{Y_{20}^{5}\cdot Y_{40}^{10}\cdot Y_{60}^{1}}+n^4\frac{Y_{20}^{700}\cdot Y_{40}^{1200}\cdot Y_{60}^{100}}{Y_{10}^{150}\cdot Y_{30}^{1300}\cdot Y_{50}^{550}}$$
$$+n^3\frac{Y_{10}^{8500}\cdot Y_{30}^{59000}\cdot Y_{50}^{20500}}{Y_{20}^{35500}\cdot Y_{40}^{49000}\cdot Y_{60}^{3500}}+n^2\frac{Y_{20}^{770000}\cdot Y_{40}^{780000}\cdot Y_{60}^{56000}}{Y_{10}^{225000}\cdot Y_{30}^{1070000}\cdot Y_{50}^{305000}}$$
$$+n\frac{Y_{10}^{2740000}\cdot Y_{30}^{6000000}\cdot Y_{50}^{1500000}}{Y_{20}^{600000}\cdot Y_{40}^{4000000}\cdot Y_{60}^{240000}}=\frac{1}{12{,}000{,}000}$$
$$\text{Log. } l_{x+n}=n^5A+n^4B+n^3C+n^2D+nE.$$

and the actual working of the formula

$$=\left\{\begin{array}{lll}
Y_{10}^{1} & =5{\cdot}0000000\times & 1= \\
Y_{30}^{10} & =4{\cdot}9610152\times & 10= \\
Y_{50}^{5} & =4{\cdot}8791511\times & 5= \\
 & & \\
Y_{20}^{5} & =4{\cdot}9817886\times & 5= \\
Y_{40}^{10} & =4{\cdot}9292275\times & 10= \\
Y_{60}^{1} & =4{\cdot}7902942\times & 1=
\end{array}\right.$$

	5·0000000
	49·6101520
	24·3957555
	79·0059075
24·9089430	
49·2922750	
4·7902942	
	78·9915122

$$A=\frac{\cdot 0143953}{12{,}000{,}000}=\cdot 000{,}000{,}001{,}199{,}6$$

$B=$	Y_{20}^{700}	$=4\cdot9817886\times$ 700 $=$		3,487·2520200
	Y_{40}^{1200}	$=4\cdot9292275\times$ 1,200 $=$		5,915·0730000
	Y_{60}^{100}	$=4\cdot7902942\times$ 100 $=$		479·0294200
				9,881·3544400
	Y_{10}^{150}	$=5\cdot0000000\times$ 150 $=$	750·0000000	
	Y_{30}^{1300}	$=4\cdot9610152\times$ 1,300 $=$	6,449·3197600	
	Y_{50}^{500}	$=4\cdot8791511\times$ 550 $=$	2,683·5331050	
				9,882·8528650

$$B=\frac{\bar{2}\cdot5015750}{12,000,000\cdot}=\cdot999,999,875,131,250$$

$C=$	Y_{10}^{8500}	$=5\cdot0000000\times$ 8,500 $=$		42,500·0000000
	Y_{30}^{59000}	$=4\cdot9610152\times$ 59,000 $=$		292,699·8968000
	Y_{50}^{20500}	$=4\cdot8791511\times$ 20,500 $=$		100,022·5975500
				435,222·4943500
	Y_{20}^{35500}	$=4\cdot9817886\times$ 35,500 $=$	1,176,853·4953000	
	Y_{40}^{49000}	$=4\cdot9292275\times$ 49,000 $=$	241,532·1475000	
	Y_{60}^{3500}	$=4\cdot7902942\times$ 3,500 $=$	16,766·0297000	
				435,151·6725000

$$C=\frac{70\cdot821850}{12,000,000\cdot}=\cdot000,005,901,820,833$$

$D=$	Y_{20}^{770000}	$=4\cdot9817886\times$ 770,000 $=$		3,835,977·2220000
	Y_{40}^{780000}	$=4\cdot9292275\times$ 780,000 $=$		3,844,797·4500000
	Y_{60}^{50000}	$=4\cdot7902942\times$ 50,000 $=$		239,514·7100000
				7,920,289·3820000
	Y_{10}^{225000}	$=5\cdot0000000\times$ 225,000 $=$	1,125,000·0000000	
	$Y_{30}^{1070000}$	$=4\cdot9610152\times$ 1,070,000 $=$	5,308,286·2640000	
	Y_{50}^{305000}	$=4\cdot8791511\times$ 3,350,000 $=$	1,488,141·0855000	
				7,921,427·3495000

$$D=\frac{\bar{1}138\cdot0325000}{12,000,000\cdot}=\cdot999,905,169,375$$

$E=$	$Y_{10}^{2740000}$	$=5\cdot0000000\times$ 2,740,000 $=$		13,700,000·0000000
	$Y_{30}^{6000000}$	$=4\cdot9610152\times$ 6,000,000 $=$		29,766,091·2000000
	$Y_{50}^{1500000}$	$=4\cdot8791511\times$ 1,500,000 $=$		7,318,726·6500000
				50,784,817·8500000
	$Y_{20}^{6000000}$	$=4\cdot9817886\times$ 600,000 $=$	29,890,731·6000000	
	$Y_{40}^{4000000}$	$=4\cdot9292275\times$ 4,000,000 $=$	19,716,910·0000000	
	Y_{60}^{240000}	$=4\cdot7902942\times$ 240,000 $=$	1,149,670·6080000	
				50,757,312·2080000

$$E=\frac{27,505\cdot6420000}{12,000,000\cdot}=\cdot002,292,136,833$$

The formula thus becomes

$$\begin{aligned}\text{Co. log. } l_{x+n} = & \; n^5 \times \cdot 000,000,001,199,608,\dot{3} \\ & + n^4 \times \cdot 999,999,875,131,250 \\ & + n^3 \times \cdot 000,005,901,820,833\dot{3} \\ & + n^2 \times \cdot 999,905,169,375 \\ & + n \times \cdot 002,292,136,833\dot{3}\end{aligned}$$

To check the accuracy of these figures let $n=10$

$$\begin{aligned}\text{Co. log. } l_{20} = & \; 100,000 \times A = \cdot 000,119,960,833 \\ + & \; 10,000 \times B = \cdot 998,751,312,5 \\ + & \; 1,000 \times C = \cdot 005,901,820,833 \\ + & \; 100 \times D = \cdot 990,516,937,500 \\ + & \; 10 = E = \cdot 022,921,368,333 \\ & \qquad\qquad \cdot 018,211,400\end{aligned}$$

$\therefore$ Log. $l_{20} = \cdot 981,788,6$ as stated.

The above constants are accordingly correct, and the table may be proceeded with. This is done by finding directly the first few values thus:—

Let $n=1$		$A = \cdot 000,000,001,199,608,\dot{3}$
		$B = \cdot 999,999,875,131,250$
		$C = \cdot 000,005,901,820,833,\dot{3}$
		$D = \cdot 999,905,169,375$
		$E = \cdot 002,292,136,833,333,\dot{3}$
Co. log. l_{11}		$= \cdot 002,203,084,360,025$
Let $n=2$	32	$A = \cdot 000,000,038,387,466$
	16	$B = \cdot 999,998,002,100$
	8	$C = \cdot 000,047,214,566,666$
	4	$D = \cdot 999,620,677,500$
	2	$E = \cdot 004,584,273,666,666$
Co. log. l_{12}		$= \cdot 004,250,206,220,800$
Let $n=3$	243	$A = \cdot 000,000,291,504,825$
	81	$B = \cdot 999,989,885,631,250$
	27	$C = \cdot 000,159,349,162,5$
	9	$D = \cdot 999,146,524,375$
	3	$E = \cdot 006,876,410,500$
Co. log. l_{13}		$= \cdot 006,172,461,173,575$

Let $n=4$	1024	$A=\cdot000,001,228,398,933$
	256	$B=\cdot999,968,033,600$
	64	$C=\cdot000,377,716,533,333$
	16	$D=\cdot998,482,710$
	4	$E=\cdot009,168,547,333,333$
Co. log. l_{14}		$=\cdot007\ 998,235,865,600$
Let $n=5$	3125	$A=\cdot000,003,748,776,041,666$
	625	$B=\cdot999,921,957,031,250$
	125	$C=\cdot000,737,727,604,166,666$
	25	$D=\cdot997,629,234,375$
	5	$E=\cdot011,460,684,166,666,666$
Co. log. l_{15}		$=\cdot009,753,351,953,125$
Let $n=6$	7776	$A=\cdot000,009,328,154,400$
	1296	$B=\cdot999,838,170,1$
	216	$C=\cdot001,274,793,300$
	36	$D=\cdot996,586,097,5$
	6	$E=\cdot013,752,821,0$
Co. log. l_{16}		$=\cdot011\ 46\ \ 210,054,400$
Let $n=7$	16807	$A=\cdot000,020,161,817,258,333$
	2401	$B=\cdot999,700,190,131,250$
	343	$C=\cdot002,024,324,545,833,333$
	49	$D=\cdot995,353,299,375$
	7	$E=\cdot016,044,957,333,333,333$
Co. log. l_{17}		$=\cdot013,142,933,602,675$
Let $n=8$	32768	$A=\cdot000,039,308,765,866$
	4096	$B=\cdot999,488,537,600$
	512	$C=\cdot003,021,732,266,666$
	64	$D=\cdot993,930,840$
	8	$E=\cdot018,337,094,666,666$
Co. log. l_{18}		$=\cdot014,817,513,299,200$
Let $n=9$	59040	$A=\cdot000,070,835,672,475$
	6561	$B=\cdot999,180,736,131,250$
	729	$C=\cdot004,302,427,387,500$
	81	$D=\cdot992,318,719,375$
	9	$E=\cdot020,629,231,500$
Co. log. l_{19}		$=\cdot016,501,950,066,225$

Co. log. l_{10} has already been found. The first eleven items in the table are thus:—

Age	10	000,000,0
„	11	997,796,915,630,975
„	12	995,749,793,779,2
„	13	993,827,438,826,425
„	14	992,001,764,134,4
„	15	990,246,648,046,875
„	16	988,538,789,945,6
„	17	986,857,066,297,375
„	18	985,182,486,700,8
„	19	983,498,049,933,775
„	20	981,788,600

from which

$$\Delta^1 = \cdot 002,203,084,360,025$$
$$\Delta^2 = \cdot 000,155,962,499,250$$
$$\Delta^3 = \cdot 000,031,095,591,250$$
$$\Delta^4 = \cdot 000,002,708,944,000$$
$$\Delta^5 = \cdot 000,000,143,953,000 \text{ Constant.}$$

The table of log. l_{x+n} may now be filled up from $n=10$ to $n=60$, which of course will exactly check at ages 20, 30, 40, 50, and 60.

If, now, the same process be repeated for ages 50, 60, 70, 80, 90, and 100, viz.:—

$$\text{Log. } l_{50} = 4\cdot 8791511$$
$$\text{„ } l_{60} = 4\cdot 7902942$$
$$\text{„ } l_{70} = 4\cdot 6067735$$
$$\text{„ } l_{80} = 4\cdot 1876616$$
$$\text{„ } l_{90} = 3\cdot 2174664$$
$$\text{„ } l_{100} = 1\cdot 0379127$$

we shall find

$$A = \cdot 000,000,014,018,200$$
$$B = \cdot 999,999,325,532,916$$
$$C = \cdot 000,028,910,425$$
$$D = \cdot 999,867,860,208,333$$
$$E = \cdot 007,850,330,500$$

which being checked by assuming $n=10$, and the value of the first ten items found and differenced, we shall have

Log. l_{50}=4·879,151,100
" l_{51}=4·871,404,659,315,550
" l_{52}= ·863,758,057,657,600
" l_{53}= ·856,060,010,561,150
" l_{54}= ·848,172,056,403,200
" l_{55}= ·839,966,874,218,750
" l_{56}= ·831,326,601,516,800
" l_{57}= ·822,141,152,096,350
" l_{58}= ·812,306,533,862,400
" l_{59}= ·801,723,166,641,950
" l_{60}= ·790,294,200

which when differenced will give

Δ^1=·007,746,440,684,450
Δ^2=·000,099,839,026,500
Δ^3=·000,151,284,465
Δ^4=·000,012,822,842
Δ^5=·000,001,682,184 Constant.

This portion of the table may now be built up, when it will reproduce the above original log. l_{50+n}, and the entire table produced from age 10 to 100.

My difficulties now commence. I have two values for the ten years from 50 to 60—the last of the first set—and the first of the second set, and my difficulty is to run the two halves together without any hitch. I have not passed much time over it, but I have no doubt that with a little attention the difficulty may nearly disappear.

I now produce the entire table:

Age x.	l_x.	Deaths.	Rate of Mortality.	Age x.	l_x.	Deaths.	Rate of Mortality.
10	100000	506	·005060	22	95114	407	4279
11	99494	468	4704	23	94707	419	4424
12	99026	437	4413	24	94288	435	4614
13	98589	414	4199	25	93853	451	·004805
14	98175	396	4034	26	93402	469	5021
15	97779	384	·003927	27	92933	487	5240
16	97395	378	3861	28	92446	506	5474
17	97019	373	3845	29	91940	525	5710
18	96646	374	3870	30	91415	546	·005973
19	96272	381	3958	31	90869	567	6240
20	95891	383	·003994	32	90302	588	6511
21	95508	394	4125	33	89714	609	6788

Age x.	l_x.	Deaths.	Rate of Mortality.	Age x.	l_x.	Deaths.	Rate of Mortality.
34	89105	632	7093	68	45328	2415	53279
35	88473	654	·007392	69	42913	2476	57698
36	87819	677	7709	70	**40437**	2528	·062517
37	87142	702	8056	71	37709	2565	67662
38	86440	726	8399	72	35344	2590	73280
39	85714	751	8761	73	32754	2600	79379
40	**84963**	779	·009169	74	50154	2591	85926
41	84184	806	·09574	75	27563	2565	·093060
42	83378	836	·10027	76	24998	2519	·100768
43	82542	867	·10504	77	22479	2453	·109124
44	81675	900	·11020	78	20026	2364	·118047
45	80775	941	·011650	79	17662	2257	·127788
46	79834	977	12238	80	**15405**	2129	·138202
47	78857	1013	12846	81	13276	1984	·149443
48	77844	1049	13476	82	11292	1823	·161475
49	76795	1085	14129	83	9469	1651	·174358
50	**75710**	1186	·015665	84	7818	1472	·188283
51	74524	1232	16532	85	6346	1286	·202647
52	73292	1278	17437	86	5060	1105	·218379
53	72014	1325	18399	87	3955	929	·234893
54	70689	1368	19353	88	3026	763	·252148
55	68321	1392	·02008Γ	89	2263	613	·270879
56	67929	1452	21375	90	**1650**	479	·290303
57	66477	1519	22850	91	1171	363	·309992
58	64958	1590	24477	92	808	268	·331683
59	63368	1667	26307	93	540	191	·353704
60	**61701**	1732	·028071	94	349	131	·375358
61	59969	1824	30415	95	218	87	·399083
62	58145	1915	32935	96	131	56	·427481
63	56230	2007	35693	97	75	34	·453333
64	54223	2097	38674	98	41	19	·463415
65	52126	2185	·041918	99	22	11	·500000
66	49941	2268	45414	100	**11**	11	1·000000
67	47673	2345	49190				

I now exhibit a check upon the correctness of any one of these numbers. Let age 37 be taken at random, that is n will equal 27:

$$27^5 \times A = 14{,}348{,}907 \cdot \times \cdot 000{,}000{,}001{,}199{,}608{,}333 = \cdot 017{,}213{,}068{,}411{,}425$$
$$27^4 \times B = 531{,}441 \cdot \times \cdot 999{,}999{,}875{,}131{,}250 = \cdot 933{,}639{,}626{,}631{,}250$$
$$27^3 \times C = 19{,}683 \cdot \times \cdot 000{,}005{,}901{,}820{,}833{,}333 = \cdot 116{,}165{,}539{,}462{,}500$$
$$27^2 \times D = 729 \cdot \times \cdot 999{,}905{,}169{,}375 = \cdot 930{,}868{,}474{,}375$$
$$27 \times E = 27 \cdot \times \cdot 002{,}292{,}136{,}833{,}333 = \cdot 061{,}887{,}694{,}500$$

$$\therefore\ 27^5A + 27^4B + 27^3C + 27^2D + 27E = \text{Co. log. } l_{37} \quad \cdot 059{,}774{,}403{,}380{,}175$$
$$\text{log. } l_{37} = \cdot 940{,}225{,}596{,}619{,}825$$

and $l_{37} = 87142$ as in table.

You will also observe that the first difference column is the log. or the Co. log. of the probability of living one year—so that the entire system of graduation as suggested by me by interpolating between the logarithms of the l_{10}, l_{20}, l_{30}, etc., submits to all our requirements and presents in a clear, unbroken chain the identical material we desire for developing those tables that are essential to the prosecution of our business.

There is only one hitch in the foregoing figures, and that hitch rests entirely with myself. You will understand that it is no part of my process to take two steps in the development. My intention was to make the interpolation by one step from age 10 to age 100, and I have the formula almost ready, but I had no spare time to dwell upon it, and the two steps seemed to me to be sufficiently exact for the purpose of illustrating the method.[1]

I have now, in conclusion, to show how far the rate of mortality involved in these consecutive numbers living when re-applied to the original numbers exposed will repeat the original number of deaths.

It has already been pointed out that the unadjusted rate of mortality in the table of mortality roughly deduced from the facts is identical with the rate in the facts themselves. I have also shown that the number of deaths in each ten years of the unadjusted table exactly coincides with the number in the adjusted table, and accordingly it is almost to be expected that the total

[1] The complete formula for the ten terms is

$$\begin{aligned}
\text{Log.}\, l_{x+n} = {} & n^9 \frac{Y_{20}{}^{9} \cdot Y_{40}{}^{84} \cdot Y_{60}{}^{126} \cdot Y_{80}{}^{36} \cdot Y_{100}{}^{1}}{Y_{10}{}^{1} \cdot Y_{30}{}^{36} \cdot Y_{50}{}^{126} \cdot Y_{70}{}^{84} \cdot Y_{90}{}^{9}} \\
& + n^8 \frac{Y_{10}{}^{45} \cdot Y_{30}{}^{1548} \cdot Y_{50}{}^{5166} \cdot Y_{70}{}^{3276} \cdot Y_{90}{}^{333}}{Y_{20}{}^{396} \cdot Y_{40}{}^{3528} \cdot Y_{60}{}^{5040} \cdot Y_{80}{}^{1368} \cdot Y_{100}{}^{36}} \\
& + n^7 \frac{Y_{20}{}^{7434} \cdot Y_{40}{}^{62496} \cdot Y_{60}{}^{84420} \cdot Y_{80}{}^{21744} \cdot Y_{100}{}^{546}}{Y_{10}{}^{670} \cdot Y_{30}{}^{28224} \cdot Y_{50}{}^{86966} \cdot Y_{70}{}^{53424} \cdot Y_{90}{}^{5166}} \\
& + n^6 \frac{Y_{10}{}^{9450} \cdot Y_{30}{}^{283,752} \cdot Y_{50}{}^{834,876} \cdot Y_{70}{}^{473,256} \cdot Y_{90}{}^{43722}}{Y_{20}{}^{77616} \cdot Y_{40}{}^{606,312} \cdot Y_{60}{}^{768,600} \cdot Y_{80}{}^{187,992} \cdot Y_{100}{}^{4536}} \\
& + n^5 \frac{Y_{20}{}^{491,841} \cdot Y_{40}{}^{3,495,996} \cdot Y_{60}{}^{4,129,398} \cdot Y_{80}{}^{961,884} \cdot Y_{100}{}^{22449}}{Y_{10}{}^{63273} \cdot Y_{30}{}^{1,710,324} \cdot Y_{50}{}^{4,632,894} \cdot Y_{70}{}^{2,475,396} \cdot Y_{90}{}^{219,681}} \\
& + n^4 \frac{Y_{10}{}^{269,325} \cdot Y_{30}{}^{6,275,052} \cdot Y_{50}{}^{15,403,374} \cdot Y_{70}{}^{7,770,924} \cdot Y_{90}{}^{666,477}}{Y_{20}{}^{1,932,084} \cdot Y_{40}{}^{12,135,312} \cdot Y_{60}{}^{13,287,960} \cdot Y_{80}{}^{2,962,512} \cdot Y_{100}{}^{67254}} \\
& + n^3 \frac{Y_{20}{}^{4,581,036} \cdot Y_{40}{}^{24,383,184} \cdot Y_{60}{}^{24,743,880} \cdot Y_{80}{}^{5,314,896} \cdot Y_{100}{}^{118,124}}{Y_{10}{}^{725,680} \cdot Y_{30}{}^{13,502,376} \cdot Y_{50}{}^{29,570,184} \cdot Y_{70}{}^{14,163,576} \cdot Y_{90}{}^{1,181,304}} \\
& + n^2 \frac{Y_{10}{}^{1,172,700} \cdot Y_{30}{}^{15,212,448} \cdot Y_{50}{}^{29,479,464} \cdot Y_{70}{}^{13,595,344} \cdot Y_{90}{}^{1,103,868}}{Y_{20}{}^{5,973,264} \cdot Y_{40}{}^{25,357,248} \cdot Y_{60}{}^{24,040,800} \cdot Y_{80}{}^{5,012,928} \cdot Y_{100}{}^{109,584}} \\
& + n \frac{Y_{20}{}^{2,265,920} \cdot Y_{40}{}^{10,160,640} \cdot Y_{60}{}^{9,144,576} \cdot Y_{80}{}^{1,866,240} \cdot Y_{100}{}^{40320}}{Y_{10}{}^{1,026,576} \cdot Y_{30}{}^{6,531,840} \cdot Y_{50}{}^{11,430,720} \cdot Y_{70}{}^{5,080,320} \cdot Y_{90}{}^{406,240}}
\end{aligned}$$

quantities A and B, and thereby giving some weight to the magnitude of the several details. To solve these equations by the ordinary methods employed in elementary determinants, and thus to find the factor or factors, which, when applied to the original q_x, will modify it in the precise direction and to the required extent, so as to make the recomputed deaths exactly coincide with the actual deaths. This method will also be found exceedingly effective in those cases where the experience of a fund, or of a company, is not of sufficient maturity to warrant the computation of a special table of mortality. It only modifies the "Standard Table" to suit the special case. It, however, opens a wide field for actuarial enterprise. If three unknown quantities are employed, two of them for the whole of life, and one for a period of say seven or ten years, corresponding to an assumed duration of selection,—it facilitates the calculation of tables giving effect to the light mortality during the years of selection, and at the same time giving expression to the heavier mortality after the benefit of selection has passed off, but combining these lighter and heavier mortalities so that the number of the total actual deaths coincides with the total recomputed deaths. Besides it is excellent actuarial practice, and may probably lead to something more useful. I do not give any example, as the subject really deserves an extensive series of examples to make it perfectly understood, but these would involve much more attention than I am at present able to undertake.

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On the preparation of a Table of Mortality from observations of various magnitudes.

BY

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On the preparation of a Table of Mortality from observations of various magnitudes.

(*Read before the Actuarial Society of Edinburgh, 20th December* 1900.)

In the paper that I had the pleasure of reading before this Society in the course of last Session, I brought forward a problem to which I promised to recur on an early occasion. That problem was a consideration of the present method of dealing with observations of various magnitudes when striking the rates of mortality experienced in each year of life. Our early mortality tables were derived from observations of a very general nature. The *gross* number of lives passing through each year of age and the number of deaths arising out of that number furnished the whole of the materials for producing the desired rate of mortality. Indeed in some instances these numbers at each age may have been ascertained by some mathematical interpolation from larger groups at younger and older ages. There was no discrimination as to the relative weights that may be allotted to any sections of these numbers. Thus in the tables derived from the numbers of the population there was no distinction between the numbers dying out of the sick and the numbers dying of the healthy. In more recent researches, however, we have improved upon our former methods of tabulation. The exact problem to be solved was not that of finding the general average rate of mortality for each year of life, but rather to ascertain the flow of mortality emanating from each group of healthy lives enrolled at each age and carefully tracing their mortalities year by year during all the subsequent years of their lives. Each group of enrolments exhibiting its own stream of mortality. There were thus many tables of mortality—each one of them being solely applicable to lives enrolled at its own initial age of entry—each exhibiting a lighter vein of mortality during the years immediately subsequent to their passing the test of being healthy lives—that is healthier than other lives of

Age.	Total Deaths.		Number exposed.	Average rate of Mortality.
35—36	295	÷	35818·5 =	·00824
36—37	326	÷	36840·5 =	·00885
37—38	357	÷	37360 =	·00956
38—39	389	÷	37804·5 =	·01029
39—40	405	÷	38112·5 =	·01063
40—41	377	÷	38915 =	·00987

As printed on page 273.

Following the same method for the $H^{M.(5)}$ table :—

Age.	Total Deaths.		Number exposed.	Average rate of Mortality.
35—36	152	÷	17479 =	·00870
36—37	205	÷	19035 =	·01077
37—38	227	÷	20308 =	·01118
38—39	247	÷	21570 =	·01094
39—40	255	÷	22618·5 =	·01124
40—41	268	÷	23455·5 =	·01143

which rates, when graduated, and made to depend from a radix of 100,000, at age 10, the youngest age, form the $H^{M.}$ and the $H^{M.(5)}$ tables of mortality with which we are supposed to be familiar.

Though no great fault can be found with all that has been described, I have, however, been accustomed to set forth the results of my method of tabulation in a different form. So early as some year long anterior to the appearance of the $H^{M.}$ table, probably about the year 1866, I remember re-arranging the statistics of the 17 Offices—published in 1843—in the form of select tables emanating from each age at entry. That table I remember sending to a gentleman in London now resident in Edinburgh, and I was modest enough or perhaps ambitious enough to imagine that it assisted in inspiring, or in fanning, the flame which ultimately matured into select tables. Also when preparing the experience of Assurance Offices in Scotland in 1864, I always preferred that arrangement of the results which collects and exhibits in one column the total numbers exposed and the total deaths in each year of life emanating from each age at entry. The present form halts at the very threshold of affording that precise information which seems to me to be so desirable to obtain. The difference between the two methods also affords me the opportunity of presenting to your notice in a very emphatic manner the groundwork of the observations which it is my pleasing duty to lay before you this evening. I annex a column or two :—

Number of Years of Life Exposed to Mortality and Number of Deaths.

From the Entrants of age in column 1 there passed through and there died at the following ages :—

Age at Entry	35		36		37		38		39		40	
	Number exposed.	Died.	Number exposed.	Died.	Number exposed.	Died.	Number exposed.	Died.	Number exposed.	Died.	Number exposed.	Died
5	1·	...	1·	...	1·	...	1·	...	1·	...	1·	...
6	...	...	...	...	...	...	...	...	...	...	...	...
7	6·	...	6·	1	5·	...	2·	...	2·	...	1·	...
8	3·5	...	2·	...	2·	...	2·	1	1·	...	1·	...
9	10·5	1	7·5	...	6·	...	5·	...	5·	...	3·	...
10	8·	...	8·	...	8·	...	8·	...	8·	1	7·	...
11	5·	...	5·	...	4·	...	4·	...	3·	...	3·	...
12	9·	...	9·	...	8·	...	7·	...	5·	...	5·	...
13	22·	...	21·	...	19·	...	16·	...	16·	1	15·	...
14	20·	...	20·	...	20·	...	19·	...	17·	...	16·	...
15	26·	...	23·5	...	22·	...	22·	...	20·5	1	18·	...
16	31·	...	29·	...	28·	1	25·	...	24·	1	22·	...
17	52·5	...	45·5	...	37·5	...	33·	...	31·	1	26·	...
18	70·	1	62·	...	54·	1	47·5	1	39·	1	31·	...
19	89·5	...	80·	3	72·5	1	62·	2	53·5	...	46·	1
20	153·5	1	136·	...	119·	2	107·	2	93·5	1	85·5	...
21	364·5	5	327·	3	290·5	6	248·5	1	215·	4	188·5	1
22	520·	5	473·	5	417·	8	367·	10	328·	3	286·5	4
23	767·5	11	683·5	12	597·	9	528·	8	472·5	11	416·	4
24	1142·5	9	1025·	15	905·	9	809·5	14	722·5	8	657·	9
25	1423·	14	1269·	11	1130·5	9	1019·	18	908·5	10	806·5	10
26	1812·	16	1618·	18	1438·	13	1275·5	9	1144·	12	1013·	13
27	2203·	21	1996·	23	1757·	25	1575·	14	1427·5	10	1281·	26
28	2509·5	15	2279·	21	2060·5	17	1870·	19	1669·	19	1506·5	15
29	3110·5	24	2853·5	27	2587·5	28	2355·	23	2138·5	24	1921·	16
30	3119·	29	2867·5	35	2606·	28	2344·	30	2138·	26	1937·	20
31	3459·	26	3188·	29	2929·	40	2650·5	35	2399·	31	2172·	24
32	3826·5	34	3494·5	36	3184·	30	2940·	30	2705·	23	2475·5	24
33	4217·	35	3866·5	27	3522·5	32	3227·5	30	2985·5	35	2729·	33
34	4492·	36	4019·5	35	3663·	36	3334·5	37	3046·	32	2817·	31
35	2345·	12	4328·	18	3875·	29	3557·	37	3243·5	40	2968·5	37
36	35818·5	295	2097·	7	3844·	22	3472·	31	3151·5	41	2828·	29
37	Total	—	36840·5	326	2147·5	11	3960·5	32	3559·5	36	3227·	29
38			Total	—	37360·	357	1910·5	5	3536·	26	3182·5	21
39					Total	—	37804·5	389	2003·5	7	3740·	21
40							Total	—	38112·5	405	1762·	9
									Total	—	38195·	377

The whole table is exhibited.

It will be observed therefrom that the numbers who had entered

at ages much earlier than the particular year of life under observation are very much fewer than the numbers who reach that year of life from entrants at the nearer ages, and consequently that the pettiness of the numbers and the weights that should be given to these numbers are very much more feeble than should be allotted to the larger numbers derived from the more recent observations. This is the problem I desire to set before you. Its solution is very simple, but I have thought it best to initiate its presentation by a few remarks of an elementary nature, these remarks leading to the solution of a higher branch of the problem which I shall also have the pleasure of laying before you.

If there be several quantities of various magnitudes and we find the exact arithmetical average thereof, and if we insert that average in the place of those quantities, and take the several differences between that average and each of the quantities the sum of the positive differences will equal the sum of the negative differences. If, however, we do not know the exact arithmetic average of the several quantities but can only guess or imagine some near approximation to that average, and if we insert that approximate average in the place of those original quantities and ascertain the errors, that is the variations between the actual quantities and the approximations, then that approximate average will be nearest the true mean when the difference between the sum of the positive and negative errors is least or is at its minimum. Thus, let the several quantities be

1st, . .	10
2nd, . .	17
3rd, . .	31
4th, . .	37
5th, . .	43

The arithmetic average therefore is $\frac{138}{5} = 27{\cdot}6$.

If now we insert this arithmetic average of 27·6 in the place of the original quantities the errors will be

	Positive.	Negative.
1st, . .	17·6	...
2nd, . .	10·6	...
3rd, . .	...	3·4
4th, . .	...	9·4
5th, . .	...	15·4

Sum of the positive errors = 28·2
Sum of the negative errors 28·2

Now, suppose we did not know the exact arithmetic average, and that we aimed at it by assuming several approximations to it, viz., 25, 26, 27, 28 and 29. If we insert these approximations in the place of the original quantities and work out the errors,—trying 25 as an approximation we shall find that the residual of the errors is 13, and so on for the other approximations as follows:—

				When the approximation is	The residual of the errors is
25—10	=	+15		25	—13
25—17	=	+ 8		26	— 8
25—31	=		- 6	27	— 3
25—37	=		-12	28	+ 2
25—43	=		-18	29	+ 7
		+23	-36 = -13		

Accordingly we observe that the true value of the arithmetic average is somewhere between 27 and 28 where the signs change, and is nearer to 28 than to 27, because 2 is nearer to 0 than 3 is. (The true value being 27·6.)

Now let us go a step further. It will be seen that a note has been taken of the amount of the positive and of the negative errors. If, however, these errors be squared this note is avoided. The test of the correctness of any approximation to the true average is when the sum of the squares of the errors is at a minimum. Thus returning to the same original quantities 10, 17, 31, 37, and 43, and inserting several approximations in their place—finding the errors—squaring these errors and finding their sum, it will be seen that the sum of the squares of the errors is at a minimum when the approximation is correct, and in proportion as the sum of the squares of the errors departs from that minimum, so does the approximate mean depart from the true mean. Thus:—

		Δ	Δ^2	When the approximation is	The sum of the squares of the errors is
28—10	=	+18	324	28·	760·
28—17	=	+11	121	27·9	759·65
28—31	=	- 3	9	27·8	759·40
28—37	=	- 9	81	27·7	759·25
28—43	=	-15	225	**27·6**	**759·20 = minimum**
			760	27·5	759·25
				27·4	759·40
				27·3	759·65
				27·2	760·
				27·1	760·45
				27·	761·

This process has received its short name as the 'Method of least Squares,' and I have taken the liberty of explaining it by aid of a mere arithmetic average. Its most appropriate field of application is in finding the most probable value of an unknown quantity which does not possess a true value, or of finding the most probable of several approximations to the true value, as I shall explain hereafter.

Mathematicians at this juncture have cultivated an immense acreage of very interesting ground upon which I do not propose to enter. The original discoverer was Gauss, who presented his process to the Royal Society of Göttingen in 1821, 1823, and 1826. Since then, the most distinguished mathematicians have rewritten up the process. I refer to the works of Todhunter—De Morgan—Glaisher—Liagre—Chauvenet—Merriman—and several others. It appears to me that some of the results of their labours may very appropriately be engrafted upon our own actuarial calculus. It is of great service in astronomical calculations where measurements have been made by two or more observers. Thus an angle has been measured 24 times under equally good conditions—the readings vary and flutter about the arithmetic average of 116° 43′ 49·64″. From the relation of the sum of the squares of the errors to the number of observations they have determined the probable error of a single observation to be

$$\cdot 6745\sqrt{\frac{92\cdot 15}{23}}=1\cdot 349''.$$

They have also determined the probable error of the arithmetic average of the several observations, so that the adjusted value of the angle may be written

$$116°43'49\cdot 64''\pm\cdot 6745\sqrt{\frac{92\cdot 15}{24\times 23}}.$$

$$116°43'49\cdot 64''\pm 0\cdot 2755''$$

In the same way the expectation of a life of 30 has been determined by several equally good observers to be

Carlisle, . .	=	34·34
H$^{M.}$, . . .	=	34·68
Chester, . .	=	31·30
Equitable, . .	=	33·98
Des Parcieux, .	=	34·06
Arithmetic average, .	=	33·672

May not the true expectation be likewise written

$$\mathring{e}_x=33\cdot 672\pm\cdot 6745\sqrt{\frac{33\cdot 672}{5\times 4}}$$

$$=33\cdot 672\pm\cdot 875.$$

The value of ·6745 being equal to $\cdot 4769 \times \sqrt{2}$, and ·4769 being the value of a mathematical quantity when the value of the integral

$$\frac{2}{\sqrt{\pi}}\int_0^{hx} e^{-h^2x^2}$$

is made equal to ·5, that is when positive and negative errors are equally probable, and is based upon the probability curve, all of which is intensely interesting.

But I have only touched upon the outside margin of the subject of least squares. It is, as I have already stated, most applicable when some unknown quantity has not an exact value. If we have two equations involving one unknown quantity we solve one of the equations and insert the result in the second equation and solve it, we thus find the most correct approximation to the unknown quantity. The value by either equation would not have been exactly correct. If we have three equations and two unknown quantities—or four equations involving three unknown quantities, or m equations and n unknown quantities, we proceed in a more systematic manner. My more especial problem is m equations and one unknown quantity, as I shall hereafter point out—the m equations being the several observations of the various entrants at each age, and the unknown quantity being the most probable value of the probability of dying in a year. In the meantime, however, the general subject will be best introduced to your notice by finding the most probable values of the three unknown quantities, S, T, and U, in the four following equations:

$$\begin{array}{rcrcrcr} S & - & T & + & 2\,U & = & 3 \\ 3\,S & + & 2\,T & - & 5\,U & = & 5 \\ 4\,S & + & T & + & 4\,U & = & 21 \\ -\,S & + & 3\,T & + & 3\,U & = & 14 \end{array}$$

If we select any three equations we may find approximate values, but they will not be the most probable values. The most probable values are those which will most closely apply to the whole four equations—those which will leave the least remainders when inserted in the original equations—those of which the squares of these remainders or errors will be at a minimum. The method is very beautiful, and is of universal application. It is not yet introduced into the affairs of common life, though many cases occur in which it might be useful—seeing that a mere direction to take the average is equivalent to a direction to make the sum of the squares of the errors the least possible—so said De Morgan.

The following are the values of the unknown quantities when the solution is confined to three equations:—

Equations	Values of S	T	U
1. 2. 3.	2·571	3·285	1·857
1. 2. 4.	2·329	3·285	1·978
1. 3. 4.	2·363	3·424	2·030
2. 3. 4.	2·473	3·581	1·876

The 'least square' method is gone about by reducing the four equations to three in the following manner and then solving. The reduction being effected by multiplying each equation by the co-efficient of each unknown quantity. The co-efficients of

S	being	1	3	4	and	-1
T	„	-1	2	1	„	3
U	„	2	-5	$+4$	„	3

The results of each such multiplication are termed Normals.

The Normal in S being

$$\begin{array}{rrcrcrcr}
 & S & - & T & + & 2\,U & = & 3 \\
 & 9\,S & + & 6\,T & - & 15\,U & = & 15 \\
 & 16\,S & + & 4\,T & + & 16\,U & = & 84 \\
 & S & - & 3\,T & - & 3\,U & = & -14 \\
\hline
\text{Sum,} & 27\,S & + & 6\,T & & - & = & 88 \\
\hline
\end{array}$$

The Normal in T being

$$\begin{array}{rrcrcrcr}
 & -S & + & T & - & 2\,U & = & -3 \\
 & 6\,S & + & 4\,T & - & 10\,U & = & 10 \\
 & 4\,S & + & T & + & 4\,U & = & 21 \\
 & -3\,S & + & 9\,T & + & 9\,U & = & 42 \\
\hline
\text{Sum,} & 6\,S & + & 15\,T & + & U & = & 70 \\
\hline
\end{array}$$

The Normal in U being

$$\begin{array}{rrcrcrcr}
 & 2\,S & - & 2\,T & + & 4\,U & = & 6 \\
 & -15\,S & - & 10\,T & + & 25\,U & = & -25 \\
 & 16\,S & + & 4\,T & + & 16\,U & = & 84 \\
 & -3\,S & + & 9\,T & + & 9\,U & = & 42 \\
\hline
\text{Sum,} & - & + & T & + & 54\,U & = & 107 \\
\hline
\end{array}$$

The three Normal equations are thus

$$\begin{array}{rrcrcrcr}
 & 27\,S & + & 6\,T & + & & = & 88 \\
 & 6\,S & + & 15\,T & + & U & = & 70 \\
 & & & T & + & 54\,U & = & 107
\end{array}$$

From these I make the following mechanical calculation

$$88 \times 15 \times 54 + 107 \times 6 - 70 \times 6 \times 54 - 88 = 49154$$

Again, to find the value of T, I substitute 88, 70, and 107 for the co-efficients of T in the second column, and write down

27	88	0
6	70	1
0	107	54

and compute the value of

$$27 \times 70 \times 54 - 6 \times 88 \times 54 - 27 \times 107 = 73548$$

and finally to find the value of U, I substitute 80, 70 and 107 for the co-efficients of U in the third column, and write down

27	6	88
6	15	70
0	1	107

and compute

$$27 \times 15 \times 107 + 6 \times 88 - 6 \times 6 \times 107 - 27 \times 70 = 37593.$$

The denominator of all the three being found from a similar operation of the unaltered co-efficients of S, T and U. Thus:—

27	6	0
6	15	1
0	1	54

$$27 \times 15 \times 54 - 6 \times 6 \times 54 - 27 = 19899.$$

The value of S being thus $49154 \div 19899 = 2{\cdot}4702$.
" T " $73548 \div 19899 = 3{\cdot}5509$.
" U " $37593 \div 19899 = 1{\cdot}9157$.

The foregoing may probably be considered the whole of the algebra of my paper. I now come to apply what I have given to our own mortality observations.

The ordinary table of mortality employed for the calculation of contingencies depending upon the duration of human life—such as the H^M table is, as we have seen, built up from a series of observations that have had their origins at nearly all ages. It is presented in the form of one large number—the radix of the table—either some number assumed to be newly born, or a number assumed to be just entering upon the youngest age in the table—such as age 10 of the H^M table, and the number who enter upon each subsequent year of age is the original number of the radix after deducting those who died in previous years. This form is the most convenient for all our calculations. It is built up from a series of independent observations made at the time when the lives were medically ascertained to be free from any apparent element of immediate mortality. These minor facts are gathered

Thus there	entered	87	at age	12	next.
"	"	99	"	11	"
"	"	86	"	10	"
"	"	61	"	9	"
"	"	50	"	8	"
"	"	37	"	7	"
"	"	30	"	6	"
"	"	20	"	5	"
"	"	22	"	4	"
"	"	23	"	3	"
"	"	42	"	2	"

and the numbers of those who entered upon the year of life 40—41 and the numbers dying out of each of these numbers were:

Entrants of Age.				
40	1762·	of whom	9	died.
39	3740·	"	21	"
38	3182·5	"	21	"
37	3227·	"	29	"
36	2828·	"	29	"
35	2968·5	"	37	"
34	2817·	"	31	"
33	2729·	"	33	"
32	2475·5	"	24	"
31	2172·	"	24	"
30	1937·	"	20	"
29	1921·	"	16	"
28	1506·5	"	15	"
27	1281·	"	26	"
26	1013·	"	13	"
25	806·5	"	10	"
24	657·	"	9	"
23	416·	"	4	"
22	286·5	"	4	"
21	188·5	"	1	"
20	85·5	"	0	"
19	46·	"	1	"
18	31·	"	0	"
17	26·	"	0	"
16	22·	"	0	"
15	18·	"	0	"
14	16·	"	0	"
13	15·	"	0	"
12	5·	"	0	"

But according to the method to be suggested by me of giving effect to the weight of each observation after the manner of least squares, I reckon that the most probable rate of mortality would be very different from $\frac{377}{38195}=\cdot0098704$.

If we have three observations thus :—

	$\frac{1}{2}$	$\frac{2}{4}$	$\frac{3}{6}$	
in the first	one	died	out of	two
„ second	two		„	four
„ third	three		„	six.

The usual mode of combining these observations is to add the deaths together and the numbers exposed together—practically forming one observation :

$$\frac{1+2+3}{2+4+6}=\frac{6}{12}=\frac{1}{2}.$$

No other mode of combining these observations will make any change upon the $\frac{1}{2}$.

In the same way if the observations had been

$$\frac{50}{100} \quad \frac{100}{200} \quad \frac{150}{300}$$

the same method of handling the figures will always give the same result of $\frac{1}{2}$.

$$\frac{50+100+150}{100+200+300}=\frac{300}{600}=\frac{1}{2}.$$

It is the most probable value of all the observations; but let one simple alteration be made upon the separate fractions without altering the general summation. Thus let the fractions be

$$\frac{49}{100}, \frac{100}{200}, \frac{151}{300}.$$

Viewed singly these observations are

$$\left.\begin{array}{l}\frac{49}{100}=\cdot4900\\ \frac{100}{200}=\cdot5000\\ \frac{151}{300}=\cdot5033\end{array}\right\}\text{the average being } 4977.$$

The mere average of the three is less than the result of the combined observation.

To my mind, however, the result should be greater than ·5, because I have increased the numerator of the fraction which has the greatest weight, and diminished the numerator of the fraction which has the smallest weight.

In the same way, if the separate observations had been

$$\frac{51}{100}, \frac{100}{200}, \frac{149}{300},$$

the resultant aggregate, arrived at in the ordinary way, would still have been ·5, viz. :—

$$\frac{51+100+149}{100+200+300}=\frac{300}{600}=\frac{1}{2},$$

the separate single probabilities being

$$\left.\begin{array}{l}\frac{51}{100}=\cdot510\\ \frac{100}{200}=\cdot500\\ \frac{149}{300}=\cdot4966\end{array}\right\}\text{the average being }\cdot5022,$$

the average of the three being greater than the general average aggregate, whereas I should expect the resultant probability to be smaller because I have reduced the numerator of the fraction that has the greatest weight, and increased the numerator of the fraction that has the smallest weight. We have thus several conflicting results.

If we average the separate probabilities that average is smaller, whereas I should expect it to be greater—or the average is greater, whereas I should expect it to be smaller, while the present ordinary method makes no change.

Turning to the basis of the H^M. table it will be found that passing through the year of life 40-41 there were in all 35 separate observations, which, when combined, make up the total material for determining the probability of dying in that year of age, viz. :—

From Entrants of Age					Probability of dying.
40	9	died	out of	1762·	=·005108
39	21	,,	,,	3740·	=·005615
38	21	,,	,,	3182·5	=·006599
37	29	,,	,,	3227·	=·008287
36	29	,,	,,	2828·	=·010255
35	37	,,	,,	2968·5	=·012464
34	31	,,	,,	2817·	=·011005
33	33	,,	,,	2729·	=·012092
32	24	,,	,,	2475·5	=·009695
31	24	,,	,,	2172·	=·011050
30	20	,,	,,	1937·	=·010325
29	16	,,	,,	1921·	=·008329
28	15	,,	,,	1506·5	=·009957
27	26	,,	,,	1281·	=·020297
26	13	,,	,,	1013·	=·012833
25	10	,,	,,	806·5	=·012399
24	9	,,	,,	657·	=·013698
23	4	,,	,,	416·	=·009615
22	4	,,	,,	286·5	=·013962
21	1	,,	,,	188·5	=·005305
20	0	,,	,,	85·5	=·000000
19	1	,,	,,	46·	=·021739
and 13	0	,,	,,	149·	=·000000
at younger ages.					
Arithmetical Average,	377	died	out of	38195·	=·009870

Average of 35 separate probabilities = = ·0065894.
" 21 " " = = ·010982.
We have the mere average = ·0065894 or ·010982,
the arithmetical average = ·0098704,
and 35 separate probabilities ranging from ·0 to ·021739.

And the question I propose to answer is, which is the most probable?

Reverting to the previous fractions of

$$\tfrac{50}{100}, \tfrac{100}{200}, \tfrac{150}{300},$$

each is a half = ·5;

and when combined the result is ·5. And if the numerator and denominator of each fraction be multiplied by its own weight—which for this purpose I have taken to be the number under observation—the denominator—the result of each is, of course, unaltered.

$$\frac{50 \times 100}{100 \times 100} = \frac{5000}{10000} = \tfrac{1}{2}$$

DETAILED EXAMPLE OF THE METHOD OF LEAST SQUARES.

Approximation.	Amount of Error in the			Sum of Errors.	Squares of the Errors in the			Sum of the Squares of the Errors.
	First Observation.	Second Observation.	Third Observation.		First Observation.	Second Observation.	Third Observation.	
·50150	1·150	·300	− ·550	+ ·900	1·322500	·090000	·302500	1·715000
·50149	1·149	·298	− ·553	+ ·894	1·320201	·088804	·305809	1·714814
·50148	1·148	·296	− ·556	+ ·888	1·317904	·087616	·309136	1·714656
·50147	1·147	·294	− ·559	+ ·882	1·315609	·086436	·312481	1·714526
·50146	1·146	·292	− ·562	+ ·876	1·313316	·085264	·315844	1·714424
·50145	1·145	·290	− ·565	+ ·870	1·311025	·084100	·319225	1·714350
·50144	1·144	·288	− ·568	+ ·864	1·308736	·082944	·322624	1·714304
·50143	1·143	·286	− ·571	+ ·858	1·306449	·081796	·326041	1·714286
·50142857	1·142857	·285714	− ·571428	+ ·857142	1·3061221	·0816326	·3265311	1·7142858
·50142	1·142	·284	− ·574	+ ·852	1·304164	·080656	·329476	1·714296
·50141	1·141	·282	− ·577	+ ·846	1·301881	·079524	·332929	1·714334
·50140	1·140	·280	− ·580	+ ·840	1·299600	·078400	·336400	1·714400

It will be observed that the Sum of the Errors (Column 5) diminishes with the lessening amount of the approximation, but that the *Sum* of the *Squares* of the Errors (Column 9) reaches its minimum when the approximate root is the 'most probable.' While positive errors are lessening, negative errors are increasing, and the neutralising effect of the sum of the increasing negative errors upon the sum of the positive errors reaches its ultimate when the sum of the squares of these errors is least or at its minimum. The cunning of the method is most beautiful, and would be more approvingly appreciated if the above illustration had been complicated with positive and with negative errors.

If this result be inserted in the original observations, and the test of the squares of the errors be applied, it will again be seen that the above value of the combined observations is beautifully satisfied. Let a series of approximations to the above result be set up and their errors ascertained and squared as in the previous example. Thus:

	error.	(error)^2	Approximation.	Sum of the Square of the Errors.	Δ^1	Δ^2
100 × ·4986 = 49·86	1·14	1·2996	·50000	2·		
200 × ·4986 = 99·72	·28	·0784	·49860	1·714400	+ 66	+ 28
300 × ·4986 = 149·58	·58	·3364	·49859	1·714334	+ 38	+ 28
Sum of the squares of the errors . . .		=1·7144	·49858	1·714296		
			·49857143	1·714285	+ 10	
			·49857	1·714286		
			·49856	1·714304	− 18	+ 28
			·49855	1·714350	− 46	+ 28
			·49854	1·714424	− 74	+ 28
			·49853	1·714526	− 102	+ 28
			·49852	1·714656	− 130	+ 28
			·49851	1·714814	− 158	+ 28
			·49850	1·715000	− 186	+ 28

The sum of the squares of the errors of the most probable result is the least of all others, and accordingly must be recognised as the true mean of the above three observations, and certainly far more correct than the result by the present process which gives no weight whatever to the several observations of unequal magnitude.

Feeling confident in the accuracy of my method for the special purposes of including in valuation reserves, when computed by an aggregate table, some residue of the unexhausted influences of selection current at date of valuation, I have computed the most probable rate of mortality at *each* age of the whole observations of the H$^{M.}$ table. The work embraces a recasting of all the facts between pages 138 to 165 of volume i., but I single out the details referring to age 40 for more special illustration.

It will be observed that of the number of the assured selected at the age of 5, and enrolled in the lists of assured lives, only one of these lived to enter upon the year of life 40—41. Of the total enrolments at age of 19, forty-six lived to enter the year of life 40—41, and of whom one died, and so on for other ages as in the first two columns of the previous page. The entire number who lived to enter upon the year of life under consideration was 38195, and of whom 377 died, consequently the ordinary method of computing the rate of mortality is the following—

$\frac{377}{38195} = \cdot 0098704$ as on pages 244 and 273, vol. i.

The separate observations furnish very varied rates of mortality, and it is only by gathering a number together in a general crush, that anything approaching to regularity in a series of observations can be obtained. In striking the above average, no effect is given to the relative magnitude at each age of the number of deaths and of the numbers exposed. Light mortality prevails mostly in observations of the largest numbers, the value of which is completely lost when mingled in a mere summation along with observations of lesser magnitude and greater mortality. There is in the entire roll of the statistics a certain strain of light mortality pervading observations among recently selected enrolments, which is completely concealed in an arithmetical average, and there is at the same time a counter strain of heavy mortality among the observations of smaller magnitude which also is ignored in the average. Each of these observations is entitled to be credited or to be debited with its own weight. If the light mortalities preponderate it is very desirable to know it, and if the heavy preponderate, by all means let the result be represented.

To give effect to these considerations I have multiplied the numerator and denominator by the respective weights of each observation, which I have taken to be fully represented by the number exposed—the denominator of the fraction. In doing this I am not augmenting the value of the single observation, but I am crediting each with all the value which it is worth.

In the present illustration of the year of life 40—41, the 'most probable' value of q_x is smaller than the ordinary value of q_x. The difference is only ·0004349, or 4 per cent. At the younger ages the differences are greater but gradually lessen towards the older ages, where the most probable value exceeds the ordinary arithmetical average as is shown in the annexed table of the entire observations in the H^M table. The differences at first do not appear to be of great significance. They have, however, a very *significant direction*, and it is *this* direction to which I especially call your attention. It is the aim and object of all my exertions to search for and to find this bias. The most probable q_x's are smaller than the ordinary q_x's up to age 55 and greater at

PROBABILITY of DYING in one year from the OBSERVATIONS of the H^m TABLE

	Ungraduated		Difference	Sum of ten terms.			Graduated Results.			Expectation of Life.		
	Giving effect to weight of each observation.	Giving no effect to weight of each observation.	Where the weighted qx is least, the difference is shown in heavy black type.	Weighted.	Unweighted.	Difference.	Giving effect to weight	Giving no effect to weight.	Difference.	J. M.	Hm.	Difference.
10	·00789	·00792	·00003	...	...	...	·00392	·00490	·00098	50·687	50·291	·396
11	·00000	·00000	·00000	...	...	...	...	...	...	...	...	...
12	·00330	·00407	·00077	...	...	...	...	...	...	...	...	...
13	·00389	·00346	·00043	...	...	...	...	...	...	...	...	...
14	·00238	·00410	·00172	...	...	...	...	...	...	...	...	...
15	·00334	·00220	·00114	...	...	...	·00322	·00297	·00025	46.492	46·161	·331
16	·00000	·00000	·00000	...	..	...	...	...	...	...	...	...
17	·00523	·00422	·00101	...	...	...	...	...	...	...	...	...
18	·00655	·00608	·00047	...	...	...	...	...	...	...	..	...
19	·00646	·00704	·00058	·03904	·03909	·00005	...	...	...	...	...	...
20	·00539	·00577	·00038	...	...	...	·00582	·00633	·00051	42·438	42·061	·377
21	·00536	·00699	·00163		...	...	...	...	...	...	...	...
22	·00552	·00625	·00073	...	..	...	...	...	...	...	...	...
23	·00627	·00773	·00146	...	...	...	...	...	...	...	...	...
24	·00706	·00686	·00020	...	...	...	...	...	...	...	...	...
25	·00450	·00514	·00064	...	...	...	·00593	·00663	·00070	38·636	38.405	·231
26	·00611	·00692	·00081	...	..	...	...	...	...	...	...	...
27	·00579	·00647	·00068	...	...	...	...	...	...	...	...	...
28	·00793	·00783	·00010	...	...	...	...	...	...	...	...	...
29	·00676	·00736	·00060	·06069	·06732	·00663	...	...	...	...	...	...
30	·00770	·00826	·00056	..	...	...	·00737	·00772	·00035	34·820	34·681	·139
31	·00672	·00736	·00064	...	...	...	...	...	...	...	...	...
32	·00827	·00832	·00005	...	...	...	...	...	...	...	...	...
33	·00811	·00831	·00020	...	...	...	...	...	...	...	...	...
34	·00828	·00869	·00041	...	...	...	...	...	...	...	...	...
35	·00812	·00824	·00012	...	...	...	·00841	·00877	·00036	31 104	31·016	·088
36	·00827	·00885	·00058	...	...	...	...	...	...	...	...	...
37	·00909	·00956	·00047	...	...	...	...	...	...	...	...	...
38	·00988	.01029	·00041	...	...	...	...	...		...	...	...
39	·01042	·01063	·00021	·08486	·08855	·00369	...	..	...	...	...	...
40	·00943	·00987	·00044	...	...	...	·00996	·01031	·00035	27·439	27·399	·040
41	·01018	·01047	·00029	...	...	...	...	...	...	...	...	...
42	·01028	·01071	·00043	...	...	...	...	...	...	...	...	...
43	·01004	·01059	·00055	...	...	...	...	...	...	...	...	...
44	·01165	·01180	·00015	...	...	...	...	...	...	...	...	...
45	·01180	·0·235	·00055	...	...	...	·01192	·01219	·00027	23·786	23·792	·006
46	·01278	·01251	·00027	...	...	...	...	...	...	...	...	...
47	·01378	·01415	·00037	...	...	...	...	...	...	...	...	...
48	·01399	·01409	·00010	...	...	...	...	...	...	...	...	...
49	·01494	·01527	·00033	·11887	·12181	·00294	...	...	...	..	...	...
50	·01629	·01650	·00021	...	...	...	·01570	·01595	·00025	20·274	20·306	·032
51	·01698	·01741	·00043	...	...	...	...	...	...	...	...	...
52	·01691	·01702	·00011	...	...	...	...	...	...	...	...	...
53	·01745	·01719	·00026	...	...	...	...	...	...	...	...	...
54	·01813	·01895	·00082	...	...	...	...	...	...	...	...	...

Ungraduated		Difference.	Sum of ten terms.			Graduated Results.			Expectation of Life.		
Giving effect to weight of each observation.	Giving no effect to weight of each observation.	Where the weighted gz is least, the difference is shown in heavy black type.	Weighted.	Unweighted.	Difference.	Giving effect to weight.	Giving no effect to weight.	Difference.	J. M.	Hs.	Difference.
·02272	·02296	**·00024**	...	...	...	·02097	·02103	**·00006**	16·906	16·962	·056
·02360	·02309	·00051	...	...	...	...	...	...	...	...	.
·02422	·02398	·00033	...	...	...	...	...	...	...	...	...
·02481	·02512	**·00031**	...	...	...	..	...	...	...	...	...
·02536	·02534	·00002	·20657	·20747	**·00090**	...	...	...	...	...	...
·03127	·03114	·00013	...	...	...	·02977	·02968	·00009	13·768	13·830	·062
·03264	·03252	·00012	..	...	...	...	...	...	...	...	...
·03531	·03461	·00070	...	...	...	...	...	...	...	...	...
·03730	·03737	**·00007**	...	...	...	...	...	...	...	...	...
·04003	·04019	**·00016**	...	...	...	...	...	...	...	..	...
·04465	·04357	·00108	...	...	...	·04389	·04343	·00046	10·955	11·012	·057
·04753	·04673	·00080	...	...	...	...	...	...	...	...	...
·05078	·04900	·00178	...	...	...	...	...	...	...	...	...
·05504	·05531	**·00027**	...	...	...	...	...	...	...	...	...
·06038	·06101	**·00063**	·43493	·43145	·00348	...	...	...	...	...	...
·05686	·05603	·00083	...	...	...	·06322	·06219	·00103	8·455	8·495	·040
·06422	·06218	·00204	...	...	...	...	...	...	...	...	...
·08165	·07972	·00193	...	...	...	...	...	...	...	...	...
·07759	·07875	**·00116**	...	...	...	...	...	...	...	...	...
·10728	·10533	·00195	...	...	...	...	...	...	...	...	...
·09522	·09432	·00090	...	...	...	09894	·09836	·00058	6·355	6·376	·021
·10431	·10652	**·00221**	...	...	...	...	...	...	...	...	...
·11056	·10874	·00182	...	...	...	...	...	...	...	...	...
·12598	·12280	·00318	...	...	...	...	...	...	...	...	...
·13731	·13604	·00127	·96098	·95043	·01055	...	...	...	...	...	...
·13927	·14070	**·00143**	...	...	...	·14558	·14465	·00093	4·715	4·719	·004
·16686	·15985	·00701	...	...	...	...	...	...	...	...	...
·16647	·17227	**·00580**	...	...	...	...	...	...	...	...	...
·19808	·20690	**·00882**	..	...	...	...	...	...	...	..	...
·17712	·17994	**·00282**	...	...	...	...	...	...	...	...	...
·20135	·21611	**·01476**	...	...	...	·20703	·20988	**·00285**	3·450	3·511	·061
·24196	·21739	·02457	...	...	...	...	...	...	...	...	...
·20833	·21790	**·00957**	...	...	...	...	...	...	...	...	.
·33550	·28415	·05135	...	...	...	...	...	...	...	...	...
·16406	·19130	**·02724**	1·99100	1·98651	·00449	...	...	...	...	...	...
·26882	·22989	·03893	...	...	...	·29768	·27945	**·00177**	2·256	2·357	·101
·33929	·31250	·02679	...	...	...	...	...	...	...	...	...
·41667	·45000	**·03333**	...	...	...	...	...	...	...	...	...
·75000	·66667	·08333	...	...	...	...	...	...	...	...	...
·00000	·00000	·00000	...	...	...	...	...	...	...	...	...
·33333	·28571	·04762	...	...	...	·73810	·63704	·10106	·969	·930	**·039**
1·00000	1.00000	·00000	3·10811	2·94477	·06334	.....	...	...	...	...	...

older ages. This combination produces larger whole-life values of policies at nearly all ages. The expectation of life is greater up to about age 40, thereafter it is less. The difference never comes up to half a year, but it is the result inspired from the method of computing with the most probable value of q_x. There are also given the values of A_x and of π_x (page 628). To obtain these values there have also been computed the values of a_x and from these the relation of values of policies by two tables have been contrasted by the formula

$$nV'x >= < nVx$$

$$\text{According as } 1-\frac{1+a'_{x+n}}{1+'a_x} >= < 1-\frac{1+a_{x+n}}{1+a_x}$$

$$\text{According as } \frac{1+a_{x+n}}{1+a_x} >= < \frac{1+a'_{x+n}}{1+a'_x}$$

$$\text{According as } \frac{1+a_{x+n}}{1+a'_{x+n}} >= < \frac{1+a_x}{1+a'_x}$$

Let $n=1$

$$\text{According as } \frac{1+a_{x+1}}{1+a'_{x+1}} >= < \frac{1+a_x}{1+a'_x}.$$

At this stage I have calculated the values of $\frac{1+a_{x+1}}{1+a'_{x+1}}$ which I have designated by the term of the 'Factor of Selection,' because if we know its value and multiply it into the values of ordinary a_x, we shall produce the values of a_x resulting from the most probable values of q_x. It may thus be applied to the tables prepared from the experience of the seventeen offices, or it may be engrafted upon the Carlisle Table or upon any other table in which there has not been incorporated in its formation any features or effects due to selection. This table I regard as most valuable. Similar factors for foreign lives—or for impaired lives—or for any other classes, would be intensely interesting.

FACTOR OF SELECTION.

20	$1{\cdot}0076=F_{20}$	30	$1{\cdot}0037=F_{30}$
21	$1{\cdot}0074=F_{21}$	31	1·0035
22	1·0069	32	1·0033
23	1·0064	33	1·0032
24	1·0058	34	1·0030
25	1·0053	35	1·0029
26	1·0048	36	1·0027
27	1·0045	37	1·0025
28	1·0042	38	1·0023
29	1·0040	39	1·0020

FACTOR OF SELECTION—*continued.*

40	1·0018 $=F_{40}$	66	·9955
41	1·0016	67	·9957
42	1·0012	68	·9958
43	1·0010	69	·9958
44	1·0007	70	·9957 $=F_{70}$
45	1·0004 $=F_{45}$	71	·9962
46	1·0001	72	·9961
47	·9999	73	·9965
48	·9997	74	·9969
49	·9995	75	·9968 $=F_{75}$
50	·9992 $=F_{50}$	76	
51	·9989	77	
52	·9986	78	
53	·9983	79	
54	·9979	80	·9985 $=F_{80}$
55	·9976 $=F_{55}$	81	
56	·9973	82	
57	·9971	83	
58	·9969	84	
59	·9967	85	·9813 $=F_{85}$
60	·9964 $=F_{60}$	86	
61	·9962	87	
62	·9959	88	
63	·9957	89	
64	·9956	90	·9660 $=F_{90}$
65	·9956 $=F_{65}$		

The above relation between values of policies and annuities may probably be similarly shown to exist between values of policies and the two rates of mortality for

$$1+a_{x+1}=\frac{a_x}{v(1-q_x)}$$

$$\text{and } \frac{1+a_{x+1}}{1+a'_{x+1}}=\frac{a_x}{a'_x}\ \frac{(1-q'_x)}{(1-q_x)}=\text{nearly } \frac{p'_x}{p_x}.$$

$\Delta_n V_x=\left(1-\frac{F_{x+n}}{F_x}\right)\left(\frac{1+a_{x+n}}{1+a_x}\right)$ which is always positive so long as F_{x+n} is less that F_x.

It remains for me to prove that the value of q_x which I have deduced from the observations satisfies the test of being the most

probable, while the value of the ordinary q_x,—the mere arithmetical average—does *not* satisfy that test. As has already been explained, the test for the 'most probable' is applied by inserting these values in the observations—finding the errors or deviations of these calculations from the facts—squaring these errors, then the most probable value is that for which the sum of the squares of the errors is the least.

In the illustration given for age 40 the most probable value of q_x was found to be

$$\frac{89105}{94436361} = \cdot 0094355 = q_x.$$

From this value of q_x I have recomputed the deaths—ascertained the deviations of that calculation from the fact, and I have squared these deviations and find the result to be

747.556,693,642,325.

I have also repeated the same calculations upon the following *approximations* to q_x—some greater and some smaller, and I annex the squares of the errors.

When the approximation is	The sum of the Squares of the errors is
·00944, . .	747.557,750,169,600
·0094355, . . .	**747.556,693,642,325**
·009435, . . .	747.556,818,040,234
·00943, . . .	747.560,658,288,9
·00900, . . .	765.092,542

In its place, I have, for the purposes of contrast, inserted the results for the most probable q_x.

These calculations have involved a considerable amount of labour, but they are not unattended with a corresponding degree of interest when they are employed in upholding the most important factor in all our actuarial calculations.

I have in a similar manner tested whether the ordinary arithmetical average **·0098704**—satisfied the test of being the most probable rate of mortality, and I find that it does *not* satisfy the test.

The sum of the squares of the errors when the

Approximate value of q_x = ·01000 = 777.538,100
" " " = ·00990 = 767.838,741,610
Arithmetical average of q_x = **·0098704 = 765.330,596,517,173**
Approximate value of q_x = 00980 = 760.030,110,440
" " " = .00970 = 754.110,206,490.

It will be seen that the first value of q_x—the value based upon the weighted mean does satisfy the test, while that based upon the arithmetical average does *not* satisfy the test of being the most probable value of q_x.

Mere magnitude of observations has no effect. Let the observations be halved—

$$\text{The ordinary } q_{40} = \frac{188{\cdot}5}{19097{\cdot}5} = {\cdot}0098704$$

$$\text{The most probable } q_{40} = \frac{222788}{23{,}609{,}090} = {\cdot}00943657$$

Let them be doubled—

$$\text{The ordinary } q_{40} = \frac{754}{76390} = {\cdot}0098704$$

$$\text{The most probable } q_{40} = \frac{3{,}564{,}620}{377{,}745{,}444} = {\cdot}00943657$$

But let the deaths among the more recent observations be assumed to belong to observations of entrants five years younger. That is

1st. Let there be no deaths among the entrants at age 40, but let them be assumed to take place among the entrants at age 35.

2nd. Let there be no deaths among the entrants at ages 39 and 40, and assume them to be placed among the entrants five years earlier, age 34 and age 35.

3rd. Let a similar transposition be assumed for ages 38, 39, and 40, and so on for other ages.

which assumptions may be viewed as artificially exaggerated effects of selection, then, while the *ordinary* q_x in each case would be ·0098704, the *most probable* q_x in the

1st case	would be	·00955158
2nd	„	·0093463
3rd	„	·0092455
4th	„	·0090147
5th	„	·0088132

Can it now be doubted that the difference between the ordinary q and the 'most probable' q is due to the variation in the strain of mortality among the entrants at the several ages, which strain, at the younger ages leans to a smaller q, and at older ages to a larger q, and thus the 'most probable' q is a more truthful exponent of the observations than the ordinary q.

COMPARISON of SINGLE AND ANNUAL PREMIUMS for £100 3 per cent.

Age.	A_x		Difference.	π_x		Difference.
	Weighted q_x J. M.	Ordinary q_x HM.		Weighted q_x J. M.	Ordinary q_x HM.	
10	26·337	26·752	·415	1·042	1·064	·022
15	29.262	29·637	·375	1·205	1·227	·022
20	32·378	32·886	·508	1·394	1·427	·033
25	35·473	35·812	·339	1·601	1·625	·024
30	38·995	39·221	·226	1·862	1·880	·018
35	42·787	42·950	·163	2·178	2·193	·015
40	46·964	47·060	·096	2·579	2·589	·010
45	51·650	51·669	·019	3·111	3·114	·003
50	56·645	56·613	·032	3·806	3·801	·005
55	61·955	61·863	·092	4·743	4·725	·018
60	67·391	67·274	·117	6·020	5·987	·033
65	72·692	72·569	·123	7·753	7·705	·048
70	77·794	77·700	·094	10·202	10·148	·054
75	82·402	82·345	·057	13·638	13·585	·053
80	86·208	86·187	·021	18·205	18·174	·031
85	89·314	89·110	·204	24·335	23·834	·501
90	92·282	92·020	·262	34·823	33·585	·238

And finally, I have computed tables of the values of Policies. This table may be prepared by the formula showing the relation of values by any two tables.

The foregoing average rate of ·0098704 is only true where the deaths are distributed among the various numbers exposed according to that rate, in which case, and in which case only that average rate becomes also the most probable rate, as the following demonstration shows :—

Years of Life 40–41.

	Ordinary q_x.						Most Probable q_x.		
Age at Entry.	Number of Deaths.		Number Exposed.		Rate of Mortality.		Number of Deaths.		Number Exposed.
5	·010	÷	1·	=	·00987	=	·01	÷	1
7	·010	÷	1·	=	·00987	=	·01	÷	1
8	·010	÷	1·	=	·00987	=	·01	÷	1
9	·030	÷	3·	=	·00987	=	·09	÷	9
10	·067	÷	7·	=	·00987	=	·47	÷	49
11	·030	÷	3·	=	·00987	=	·08	÷	9
12	·049	÷	5·	=	·00987	=	·25	÷	25
13	·148	÷	15·	=	·00987	=	2·22	÷	225
14	·158	÷	16·	=	·00987	=	2·53	÷	256
15	·178	÷	18·	=	·00987	=	3·20	÷	324
16	·217	÷	22·	=	·00987	=	4·77	÷	484
17	·257	÷	26·	=	·00987	=	6·68	÷	676
18	·306	÷	31·	=	·00987	=	9·49	÷	961
19	·454	÷	46·	=	·00987	=	20·88	÷	2,116
20	·844	÷	85·5	=	·00987	=	72·08	÷	7,310
21	1·860	÷	188·5	=	·00987	=	350·80	÷	35,532
22	2·828	÷	286·5	=	·00987	=	810·22	÷	82,082
23	4·106	÷	416·	=	·00987	=	1708·10	÷	173,056
24	6·485	÷	657·	=	·00987	=	4260·64	÷	431,649
25	7·960	÷	806·5	=	·00987	=	6419·74	÷	650,443
26	9·999	÷	1013·	=	·00987	=	10218·98	÷	1,026,169
27	12·644	÷	1281·	=	·00987	=	16196·96	÷	1,640,961
28	14·870	÷	1506·5	=	·00987	=	22401·65	÷	2,269,542
29	18·961	÷	1921·	=	·00987	=	36424·08	÷	3,690,241
30	19·119	÷	1937·	=	·00987	=	37033·50	÷	3,751,969
31	21·439	÷	2172·	=	·00987	=	46565·51	÷	4,717,584
32	24·434	÷	2475·5	=	·00987	=	60486·37	÷	6,128,100
33	26·936	÷	2729·	=	·00987	=	73508·34	÷	7,447,441
34	27·805	÷	2817·	=	·00987	=	78326·69	÷	7,935,489
35	29·300	÷	2968·5	=	·00987	=	86977·05	÷	8,811,992
36	27·914	÷	2828·	=	·00987	=	78940·79	÷	7,997,584
37	31·852	÷	3227·	=	·00987	=	102786·40	÷	10,413,529
38	31·413	÷	3182·5	=	·00987	=	99971·87	÷	10,128,307
39	36·915	÷	3740·	=	·00987	=	138062·10	÷	13,987,600
40	17·392	÷	1762·	=	·00987	=	30644·70	÷	3,104,644
	377·		38195·				932157·267		94,436,361

$$q_{40} = \frac{377}{38,195} = 0098704\cdot \qquad q_{40} = \frac{932,157\cdot 26}{94,436,361\cdot} = 009870$$

Moreover there is this very important consideration to be kept in view, that in a valuation of the ordinary type the values of the *individual* Policies are never required to be separately stated, only the aggregate values under each class of risk.

If it were desired to state the separate values of each of the Policies, it might be thought necessary to find out by re-examination which of the lives possessed any remaining virtues of selection, and to calculate the values accordingly, but Select tables from the Office point of view may probably be assumed to be sufficient for that purpose, though it is quite conceivable that the unhealthy life may claim that his Policy was of a higher value than the Policy of the healthy life. Select tables probably are more applicable for *accurate premiums* and for *individual values of Policies*, but the aggregate tables based upon the 'most probable' values of q_x seem to me to be more appropriate and sufficiently accurate for all the general purposes of a valuation.

I have further experimented with the tabulated statistics of Female Annuitants published by Government. The total aggregate experience is given on page 19, and the sectional parts of that experience on pages 54 and 67 of the Report dated 10th February 1883. The sectional parts tabulated for the purpose of tracing the mortality of entrants at each age have been recast for my own purposes in the manner already explained. I have therefrom computed the most probable values of q_x and graduated the results according to Woolhouse's method. These q_x's I now contrast, first in their ungraduated form—

UNGRADUATED.

Age.	Unweighted q_x Finlaison.	Weighted q_x J. M.	Difference.
50	·00988	·00939	·00049
51	·01281	·01213	·00068
52	·01287	·01086	·00201
53	·01434	·01291	·00143
54	·01459	·01314	·00145
55	·01547	·01488	·00059
56	·01717	·01575	·00142
57	·01763	·01594	·00169
58	·01777	·01804	·00027
59	·02214	·02035	·00179
60	·02148	·01935	·00213
61	·01865	·01783	·00082
62	·02299	·02172	·00127

Age.	Unweighted q_x Finlaison.	Weighted q_x J. M.	Difference.
63	·02445	·02335	·00110
64	·02600	·02363	·00237
65	·03196	·02987	·00209
66	·03026	·02866	·00160
67	·03587	·03430	·00157
68	·04019	·03784	·00235
69	·03914	·03922	·00008
70	·04348	·04188	·00160
71	·04767	·04762	·00005
72	·05188	·05182	·00006
73	·06488	·06300	·00188
74	·06864	·06812	·00052
75	·07942	·08078	·00136
76	·08272	·08380	·00108
77	·08665	·08546	·00119
78	·09602	·09795	·00193
79	·10539	·10414	·00125
80	·11645	·11553	·00092
81	·13203	·13488	·00285
82	·13237	·13524	·00287
83	·15586	·15828	·00242
84	·15402	·15668	·00266
85	·18519	·18622	·00103
86	·19939	·20080	·00141
87	·22467	·22367	·00100
88	·20594	·20877	·00283
89	·26158	·26103	.00055
90	·28250	·27145	·01105
91	·29210	·29477	·00267
92	·27068	·29236	·02168
93	33210	·33273	·00063
94	·32600	·37423	·04823
95	·39241	·43842	·04601

Second, in their graduated form—

GRADUATED.

Age.	Unweighted q_x Finlaison.	Weighted q_x J. M.	Difference.
50	·01123	·00791	·00332
51	·01211	·00991	.00220

From which it will be observed that the weighted q_x possesses the character of yielding larger values of Policies, but as the statistics have been prepared from the mortality observations on the lives of annuitants, the functions derived therefrom are most appropriate for calculating on the lives of annuitants. I accordingly contrast the a_x's.

COMPARISON OF THE a_x's.

Age.	Value of a_x from the unweighted q_x.	Value of a_x from the weighted q_x.	Difference.
50	15·433	15·669	·236
51	15·077	15·263	·186
52	14·720	14·878	·158
53	14·357	14·511	·154
54	13·994	14·150	·156
55	13·633	13·789	·156
56	13·268	13·424	·156
57	12·898	13·052	·154
58	12·527	12·673	·146
59	12·150	12·287	·137
60	11·764	11·892	·128
61	11·370	11·490	·120
62	10·971	11·079	·108
63	10·564	10·660	·096
64	10·156	10·239	·083
65	9·751	9·819	·068
66	9·348	9·401	·053
67	8·948	8·986	·038
68	8·550	8·574	·024
69	8·150	8·162	·012
70	7·752	7·754	·002
71	7·357	7·351	·006
72	6·971	6·959	·012
73	6·597	6·579	·018
74	6·240	6·219	·021
75	5·898	5·874	·024
76	5·571	5·543	·028
77	5·253	5·224	·029
78	4·946	4·915	·031
79	4·644	4·610	·034
80	4·352	4·316	·036
81	4·067	4·030	·037

Age.	From the unweighted q_x.	From the weighted q_x.	Difference.
82	3·795	3·758	·037
83	3·532	3·496	·036
84	3·282	3·249	·033
85	3·043	3·013	·030
86	2·821	2·792	·029
87	2·605	2·574	·031
88	2·409	2·373	·036
89	2·226	2·176	·050
90	2·061	1·990	·071

Greater Annuity values during the first 20 years, and lesser values after age 70 seem to me to be a more accurate representation of the facts for general purposes than either the ordinary q_x or the q_x's derived from select tables.

But let it be assumed for a moment that the Statistics be applicable to assured lives and to whole life assurances, I have computed the Factor of Selection in the manner already explained. It was derived from the relation of the two annuities

$$\frac{1+a_x}{1+a'_x}=\text{Factor.}$$

FACTOR OF SELECTION.

	Factor.		Factor.
50	1·0144	65	1·0064
51	1·0116	66	1·0052
52	1·0100	67	1·0038
53	1·0101	68	1·0026
54	1·0104	69	1·0013
55	1·0106	70	1·0002
56	1·0109	71	·9993
57	1·0111	72	·9984
58	1·0108	73	·9976
59	1·0104	74	·9970
60	1·0100	75	·9965
61	1·0097	76	·9958
62	1·0090	77	·9954
63	1·0083	78	·9947
64	1·0075	79	·9940

	Factor.		Factor.
80	·9932	85	·9924
81	·9927	86	·9924
82	·9923	87	·9915
83	·9920	88	·9891
84	·9922	89	·9847
		90	·9766

and from the values of Annuities there have been computed the values of Policies of £100 payable at death by ordinary contributions during life.

Comparison of Values of Policies.

1. Age at Entry.

50

After years.	On the Ordinary q_x.	On the Weighted q_x.	Difference. Weighted q_x. greater.
5	10·954	11·280	·326
10	22·327	22·659	·332
15	34·577	35·093	·516
20	46·741	47·484	·743
25	58·024	58·764	·740
30	67·432	68·112	·680
35	75·397	75·929	·532
40	81·373	82·067	·694

2. Age at Entry.

55

5	12·772	12·825	·053
10	26·529	26·840	·311
15	40·190	40·807	·617
20	52·860	53·521	·661
25	63·425	64·058	·633
30	72·370	72·868	·498
35	79·182	79·787	·605

3. Age at Entry.

60

After years.	On the Ordinary q_x.	On the Weighted q_x.	Difference. Weighted q_x greater.
5	15·771	16·077	·306
10	31·432	32·199	·767
15	45·958	46·683	·725
20	58·070	58·770	·700
25	68·325	68·877	·552
30	76·018	76·867	·849

4. Age at Entry.

65

5	18·594	19·091	·497
10	35·839	36·469	·630
15	50·219	50·871	·652
20	62·394	62·914	·520
25	71·528	72·371	·843

5. Age at Entry.

70

5	21·184	21·479	·295
10	38·849	39·279	·430
15	53·805	54·164	·359
20	65·025	65·852	·827

These calculations amply prove that the principle of computing the most probable values of q_x by giving effect to the magnitudes of the several observations in the manner already explained, and of incorporating these values in the form of an aggregate table in the usual way, has the property of showing larger values of policies than when the q_x is derived from the mere summation of the numbers exposed and the number of deaths, without giving any effect to the magnitude of the observations; and looking to the sources from which these most probable values of q_x are obtained,

there is no doubt that these larger values of Policies are due to the incorporation of the benefits of Select tables put in an aggregate form, which is so greatly desired for valuation purposes.

Making still further experiment, and feeling confident in the trustworthiness of the material, I have contrasted the two q_x's derived from the MS. statistics of Males assured in the ten Scottish Offices to December 1863—the one set referring to ages 35-39, and the other to ages 55-59. We know from previous illustrations that have been worked to a conclusion that, if the most probable q_x be smaller than the ordinary q_x at younger ages, and greater at older ages, the values of Policies will be greater when derived from the most probable q_x than when derived from the ordinary q_x, thus:—

Age.	Ordinary q_x.	Most probable q_x.	Difference.
35	·008434	·008395	·000039
36	·009811	·009250	·000561
37	·009866	·009591	·000275
38	·009924	·009532	·000392
39	·010590	·010372	·000218
*	*	*	*
55	·023150	·023347	·000197
56	·022709	·022857	·000148
57	·022999	·023841	·000842
58	·025133	·024860	·000273
59	·023804	·023893	·000089

From all these examples it is perfectly evident that values of Policies based upon the functions derived from the most probable q_x would be always greater—more or less—than the values prepared in the usual way from the ordinary q_x.

I have also employed for additional illustration the statistics of the new Combined Experience of Assured Lives as furnished in the recent volume of Unadjusted Data. I did not find the material quite ready to hand, because, unfortunately for my purpose, the data comprised in the 'Select' and in the 'Aggregate' Tables are not identical. As mentioned in the memorandum prefixed to the volume, duplicate periods of risk were eliminated independently, so that a life on which repeated assurances were effected is reckoned more than once in the 'Select' Tables, though only once in the 'Aggregate.' The effect is that there are 121,055 more 'entrants' in the former than in the latter, and therefore the

lighter mortality among entrants at the assuring ages correspondingly developed. There are 36,390 more deaths, and therefore the death rate at the older ages correspondingly pronounced. To compare the results of these facts with the results of the one printed aggregate table which excludes these extra elements would not be a fair comparison, but in order to render the comparison just and fair, I have prepared a hypothetical aggregate table from the sum of the sectional tables. The entrants and the deaths and the years of life are thus the same in the two tables. The materials in my comparison thus start fair. I have now only to point out the difference between the results of two modes of computing q_x. From the difference in the constituent parts of the two tables we should expect to find an extra lightness of mortality at the assuring ages, and a heavier mortality at the dying ages, the sure forecasts of larger values of Policies. These tables embrace 177,279 deaths and 8,647,246 years of life.

The relation of rates of mortality to values of Policies is a very interesting subject. If we represent one standard rate of mortality by a horizontal line, it is possible to have Tables with heavier rates of mortality and other Tables with lighter rates of mortality, all giving values of Policies equal to the value by the horizontal standard. These q_x's being thus as it were parallel to each other: but if we have a q_x which shows heavier mortality at the entering ages, and lighter mortality at the dying ages, the values of Policies will be smaller than the values by the standard, and if we have a q_x which shows lighter mortality at the assuring ages and heavier mortality at the dying ages the values of Policies will be greater by that table than by the standard table. In the comparisons which I have laid before you —from the sectional and the aggregate of the H^M and from the sectional and the aggregate of the Government annuitants—each life has been enrolled and selected only once, and each death has been entered only once, but in the comparison prepared from the sum of the sectional tables of the New combined experience and from the hypothetical aggregate table many lives — probably thousands of them—have been enrolled and selected more than once, and those of them who have died have been entered as double, triple or more deaths. The essential features of larger values of Policies are thus present in an extra measure. There is as it were a double dose of selection and a heavier degree of mortality.

The differences shown in the following Table are in the expected direction, and denote larger values of Policies, but they do not appear to be so pronounced as from the nature of the tables might have been looked for.

COMPARISON OF RATES OF MORTALITY MADE UP FROM THE SUM OF THE SELECT TABLES OF THE NEW COMBINED EXPERIENCE.

Age.	Ordinary q_x ungraduated.	Sum of five.	Most probable q_x graduated.	Sum of five.	Difference.
20	·00429	...	·00360	...	...
21	·00409	...	·00362	...	...
22	·00435	...	·00370	...	...
23	·00418	...	·00376	...	...
24	·00518	·02209	·00390	·01858	·00351
25	·00501	...	·00407	...	...
26	·00458	...	·00428	...	...
27	·00491	...	·00440	...	...
28	·00523	...	·00460	...	...
29	·00539	·02512	·00488	·02223	·00289
30	·00565	...	·00518	...	...
31	·00581	...	·00550	...	...
32	·00623	...	·00583	...	...
33	·00655	...	·00629	...	...
34	·00727	·03151	·00664	·02944	·00207
35	·00727	...	·00703	...	...
36	·00753	...	·00735	...	...
37	·00808	...	·00761	...	...
38	·00814	...	·00794	...	...
39	·00799	·03901	·00830	·03823	·00078
40	·00884	...	·00868	...	...
41	·00923	...	·00912	...	...
42	·00965	...	·00969	...	...
43	·01042	...	·01019	...	...
44	·01112	·04926	·01074	·04842	·00084
45	·01096	...	·01129	...	...
46	·01166	...	·01190	...	...
47	·01200	...	·01250	...	...
48	·01341	...	·01325	...	...
49	·01381	·06184	·01400	·06294	·00110
50	·01529	...	·01490	...	...
51	·01536	...	·01587	...	...
52	·01660	...	·01692	...	...
53	·01793	...	·01801	...	...
54	·01866	·08384	·01933	·08503	·00119

I shall now conclude with a statement of the very interesting problem, referred to in the course of the present paper, that the system of calculations now presented led up to.

Suppose we have the limited experience of a Fund, and are unable to find a complete table of mortality expressing that experience, and on which we are probably desirous of making a valuation of its liabilities. We may, however, take any table we please, and so bend it and shape it that it shall not only represent that limited experience, but may also show such a completed experience as may be thought sufficient for valuation purposes. My problem is illustrated entirely by imaginary figures. I have plenty of real cases about me, having toyed with the problem for some years, and sometimes I am proud enough to imagine that I know a good deal about it; but more mature consideration leads me to state that the more I work at it the less precise is the knowledge I seem to gain. Many interruptions and the absence of some practical application may probably have a good deal to do with that. The proper solution demands more than mere calculation. Judgment and prudence are as great factors as figures. I merely produce an illustration of the method.

Imagine a fund with a certain limited mortality experience. The numbers exposed and the deaths at each year of life have been ascertained. By applying any well-known table of approved graduation to the number exposed, we find certain numbers of expected deaths. Let the

Actual deaths be = 14, 16, 18, 20, 22, 24, 26, 28, 30, 32.
and the estimated deaths be = 12, 14, 17, 21, 26, 26, 26, 26, 26, 26.

I then set up the following equations :—

Age.	Original Equations.
x	$12A + 12B = 14$
$x+1$	$28A + 14B = 16$
$x+2$	$51A + 17B = 18$
etc.	$84A + 21B = 20$
	$130A + 26B = 22$
	$156A + 26B = 24$
	$182A + 26B = 26$
	$208A + 26B = 28$
	$234A + 26B = 30$
	$260A + 26B = 32$
	220 230

I then find, in the manner already described, the most probable values of A and of B. If I had more leisure I would have preferred introducing a third unknown quantity C, but in the meantime two will be enough. I now produce the Normal *equations in A and in B.*

Normal in A			Normal in B		
$144A+$	$144B=$	168	$144A+$	$144B=$	168
$784A+$	$392B=$	448	$392A+$	$196B=$	224
$2601A+$	$867B=$	918	$867A+$	$289B=$	306
$7056A+$	$1764B=$	1680	$1764A+$	$441B=$	420
$16900A+$	$3380B=$	2860	$3380A+$	$676B=$	572
$24336A+$	$4056B=$	3744	$4056A+$	$676B=$	624
$33124A+$	$4732B=$	4732	$4732A+$	$676B=$	676
$43264A+$	$5408B=$	5824	$5408A+$	$676B=$	728
$54756A+$	$6084B=$	7020	$6084A+$	$676B=$	780
$67600A+$	$6760B=$	8320	$6760A+$	$676B=$	832
$250565A+$	$33587B=$	35714	$33587A=$	$5126B=$	5330

The two equations from which A and B are to be found are:—

$$250565A+33587B=35714$$
$$33587A+5126B=5330$$

from which

$$A=\frac{35714\times5126-33587\times5330}{250565\times5126-(33587)^2}=\frac{4051254}{156309621}=\cdot025918$$

and $$B=\frac{250565\times5330-35714\times33587}{250565\times5126-(33587)^2}=\frac{135985332}{156309621}=\cdot869976$$

I now prepare a table of Modifiers, as I have termed them, thus:—

Modifier of	q_x	$=\cdot895894=$	$A+B$
,,	q_{x+1}	$=\cdot921812=$	$2A+B$
,,	q_{x+2}	$=\cdot947730=$	$3A+B$
,,	q_{x+3}	$=\cdot973648=$	$4A+B$
,,	q_{x+4}	$=\cdot999566=$	$5A+B$
,,	q_{x+5}	$=1\cdot025484=$	$6A+B$
,,	q_{x+6}	$=1\cdot044879=$	$7A+B$
,,	q_{x+7}	$=1\cdot064274=$	$8A+B$
,,	q_{x+8}	$=1\cdot083669=$	$9A+B$
,,	q_{x+9}	$=1\cdot103064=$	$10A+B$

which modifiers, when applied to the q_x of the assumed table and re-applied to the number exposed, will reproduce the actual number of deaths; and a continuation of the same stream of modifiers to the end of the assumed table will produce a table of mortality applicable to the particular fund, and which may be adopted for the valuation. These modifiers, you will bear in mind, are the most probable of any other pair whatever. I have considered that this simple problem may yet take an important stand in many of our actuarial calculations.

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